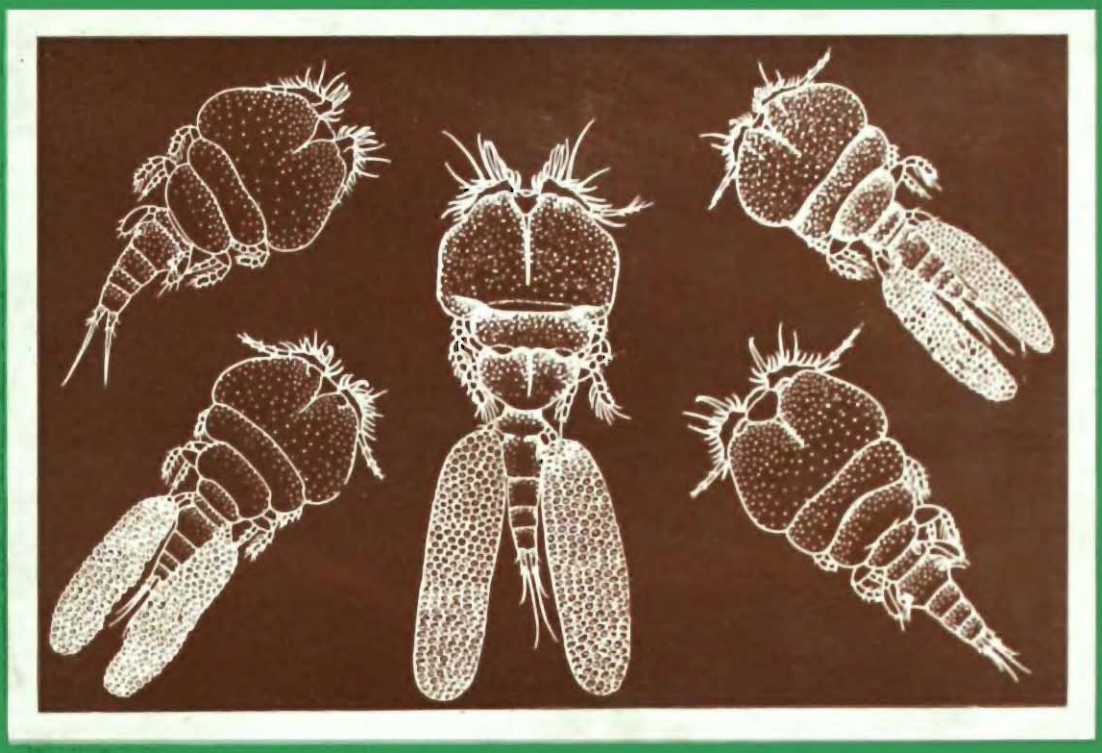

# Fauna of India

## PARASITIC COPEPODS OF MARINE FISHES

N. KRISHNA PILLAI

Copepods parasitic on fishes display a wide range of adaptive modifications and have always fascinated students of biology. Though they may not, under natural conditions, bring about the death of the hosts, it is established that parasitic infection brings about deterioration of the quality of the flesh. Hence copepod parasites have considerable economic importance.

India has recently embarked on a scientific exploitation of the fishery resources and fishery scientists will have to identify the parasites correctly. This is at present somewhat difficult because of the absence of a suitable reference work. This book which provides illustrated descriptions of 314 species of parasites, hitherto recorded from the waters around the Indian pensinsula, is expected to fill this void.

The 314 species so far recorded form only a fraction of those which actually inhabit the Indian waters. Those who wish to take up the study of the copepod parasites of fishes, will find in this book all the background knowledge necessary for their work.

# THE FAUNA OF INDIA

## COPEPOD PARASITES

## OF

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## COPEPOD PARASITES OF MARINE FISHES


BY

**N. KRISHNA PILLAI**

*Department of Aquatic Biology and Fisheries*
*University of Kerala, Trivandrum*

Edited by the Director, Zoological Servey of India
1985

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"It is common to find parasites referred to as if they were in some way more morally oblique in their habits than other animals, as if they were taking some unfair and mean advantage of their hosts. If we once start working out such "responsibilities" we find that the whole animal kingdom lives on the spare energy of other species or upon plants, while the latter depend upon the radiant energy of the sun. If parasites are to occupy a special place in this scheme we must, to be consistent, accuse cows of petty larceny against grass, and cactuses of cruetly to the Sun"

—CHARLES ELTON

## CONTENTS


| | *Page* |
|---|---|
| Editor's Preface | ix |
| Author's Preface | xi |
| Systematic Index | xiii |
| Introduction | 1 |
| Faunal Boundary | 2 |
| Collection, Examination and Preservation of Specimens | 3 |
| Morphology | 6 |
| Host-Parasite Relationship | 12 |
| Ecology | 19 |
| Ontogeny | 22 |
| Description of Species | 34 |
| References | 816 |
| List of Synonyms | 835 |
| List of Hosts and their Parasites | 837 |
| Addendum | 867 |
| Index | 885 |

# EDITOR'S PREFACE

There has not been much published work on the parasitic Copepods of Indian marine fishes. A few attempts have been made by foreign Carcinologists on stray Indian material. No comprehensive work on this group is so far known and as such the present treatise by Dr. N. Krishna Pillai, former Head of the Department of Aquatic Biology and Fisheries, University of Kerala, Trivandrum, is a welcome contribution fulfilling a much needed demand. Dr. Krishna Pillai needs no introduction ; he is a very senior worker of our country in the field of systematic Carcinology and an internationally reknowned scientist on parasitic Copepods. He has to his credit a rich experience borne out of several years of painstaking research and has several papers besides having trained a number of young workers in his specialisation.

The present volume contain descriptions of 314 species of Copepods known so far as parasites of marine fishes of our waters. A host specific list has also been given at the end which will be useful. The author has been able to examine most of the type material of species included here, both from Indian and foreign repositories. Wherever the taxonomy of a particular was in confusion he has clarified the same. Almost all the illustrations have been executed by him which is creditable. It is unfortunate however that he could not provide illustrations for 65 species the material of which he could not examine. This is all the more poignant since these 65 species are those which are very poorly described and a fresh examination of these would have improved the value and utility of this work.

This book is a comprehensive treatise and I am sure it will be found useful by not only carcinologists but also fishery workers. Dr. Krishna Pillai deserves the heartfelt thanks and congratulations of all zoologists for his excellent work.

B. K. TIKADER
*Director*
Zoological Survey of India

Calcutta.
6th September, 1985

# AUTHOR'S PREFACE

In 1959 the Department of Aquatic Biology and Fisheries, University of Kerala, started post-graduate course in Marine Biology and Oceanography. As the person responsible for teaching Carcinology, I was on the look out for material for practical work for collecting crustacean parasites and began examining fishes. I was at once struck by the variety of copepods parasitic on fishes and the ease with which they could be collected. During the course of a year about 70% of the species till then reported from the Indian waters were collected and a surprisingly large number of them proved to be either new, or new records for the region.

The literature on the copepod parasites of Indian waters is scattered and the descriptions of a large number of species are not at all accurate. Further during the last two decades I have been regularly receiving requests for identifying copepod parasites, which a person busy with his own work could not easily acceed to. I, therefore, wanted to present all the available information in a single publication which would be readily available to all. Hence the request from the Director, Zoological Survey of India to write a Fauna of India volume on copepod parasites of fishes was gladly accepted.

In all 314 species have been described in this work. Of these 65 have not been illustrated as specimens could not be obtained for study. This is unfortunate because the available descriptions of many of these species are very unsatisfactory.

The manuscript of this book was submitted for publication in 1979 but due to several reasons the final printing has been delayed. In the meantime during the last five years a large number of important publications including a monographic study by Dr. Z. Kabata got published, which has rendered certain portions of this work, especially the classification adopted, out of date. An addendum has therefore been added.

During the last five years my students have collected several species not hitherto recorded from the Indian waters. As the descriptions of this material are yet to be published I could not make use of these collections in this work. If these undescribed species are also to be included the total number of species recorded from the Indian waters will go beyond 400.

Copepods parasitic on fishes display a wide range of adaptive modifications and have always fascinated students of biology. Though they may not, under natural conditions, bring about the death of the hosts, it is established that parasitic infection brings about deterioration of the quality of the flesh. Hence copepod parasites have considerable economic importance.

India has recently embarked on a scientific exploitation of the fishery resources and fishery scientists will have to identify the parasites correctly. This is at present somewhat difficult because of the absence of a suitable reference work. This book, which provides illustrated descriptions of 314 species of parasitic copepods hitherto recorded from the waters around the Indian peninsula, is expected to fill this void.

The 314 species so far recorded form only a fraction of those which actually inhabit the Indian waters. Those, who wish to take up the study of the copepod parasites of fishes, will find in this book all the background knowledge necessary for their work.

Trivandrum
28th August, 1985

N. KRISHNA PILLAI

## SYSTEMATIC INDEX


| | *Page* |
|---|---|
| Order COPEPODA | 27 |
| Suborder CYCLOPOIDA | 29 |
| Family BOMOLOCHIDAE | 30 |
| Subfamily BOMOLOCHINAE | 31 |
| Genus **Bomolochus** Nordmann | 32 |
| *Bomolochus bellones* Burmeister | 34 |
| *Bomolochus hemirhamphi* Pillai | 36 |
| *Bomolochus megaceros* Heller | 38 |
| *Bomolochus monoceros* Pillai | 41 |
| *Bomolochus multiceros* Pillai and Natarajan | 43 |
| *Bomolochus selaroides* Pillai | 47 |
| Genus **Holobomolochus** Vervoort | 48 |
| *Holobomolochus nemipteri* Pillai | 42 |
| Genus **Nothobomolochus** Vervoort | 52 |
| *Nothobomolochus cypseluri* (Yamaguti) | 54 |
| *Nothobomolochus denticulatus* (Bassett-Smith) | 57 |
| *Nothobomolochus digitatus* Cressey and Collette | 60 |
| *Nothobomolochus gerresi* Pillai | 61 |
| *Nothobomolochus gibber* (Shiino) | 63 |
| *Nothobomolochus kanagurta* (Pillai) | 66 |
| *Nothobomolochus multispinosus* (Gnanamuthu) | 69 |
| *Nothobomolochus quadriceros* Pillai | 72 |
| *Nothobomolochus triceros* (Bassett-Smith). | 74 |
| *Nothobomolochus trichiuri* Pillai and Natarajan | 77 |
| Genus **Orbitacolax** Shen | 80 |
| *Orbitacolax aculeatus* (Pillai) | 81 |
| Genus **Pseudorbitacolax** Pillai | 83 |
| *Pseudorbitacolax varunae* (Bennet) | 84 |
| Genus **Pumiliopes** Shen | 87 |
| *Pumiliopes jonesi* (Bennet) | 88 |
| Genus **Pumiliopsis** Pillai | 89 |
| *Pumiliopsis sardinellae* (Bennet) | 90 |
| *Pumiliopsis plautus* Cressey and Boyle | 94 |

| | Page |
|---|---|
| Family TAENIACANTHIDAE | 96 |
| Genus **Taeniacanthus** Sumpf | 98 |
| *Taeniacanthus dentatus* Sebastian | 99 |
| *Taeniacanthus indicus* Pillai | 100 |
| *Taeniacanthus lagocephali* Pearse | 102 |
| *Taeniacanthus longicaudus* Pillai | 104 |
| *Taeniacanthus narcini* Pillai | 107 |
| *Taeniacenthus tetradonis* (Bassett-Smith) | 109 |
| Genus **Parataeniacanthus** Yamaguti | 109 |
| *Parataeniacanthus miles* Pillai | 111 |
| *Parataeniacanthus longicervis* Pillai | 113 |
| Genus **Metataeniacanthus** Pillai | 115 |
| *Metataeniacanthus synodi* Pillai | 116 |
| Genus **Pseudotaeniacanthus** Yamaguti and Yamasu | 118 |
| *Pseudotaeniacanthus longicauda* Pillai and Hameed | 119 |
| Genus **Anchistrotos** Brian | 121 |
| *Anchistrotos sauridi* Pillai | 122 |
| Family CHONDRACANTHIDAE | 123 |
| Subfamily CHONDRACANTHINAE | 124 |
| Genus **Chondracanthus** De Laroche | 125 |
| *Chondracanthus elongatus* Bassett-Smith | 125 |
| Genus **Protochondracanthus** Kirtisinghe | 127 |
| *Protochondracanthus alatus* (Heller) | 128 |
| *Protochondracanthus trilobatus* (Pillai) | 130 |
| Genus **Heterochondria** Yu | 132 |
| *Heterochondria pillaii* Ho | 133 |
| *Heterochondria longa* Tripathi | 134 |
| Genus **Ceratochondria** Yu | 136 |
| *Ceratochondria hoi* sp.nov. | 136 |
| Genus **Medesicaste** Kroyer | 138 |
| *Medesicaste penetrans* Heller | 138 |
| Suborder CALIGOIDA | 139 |
| Family DISSONIDAE | 140 |
| Genus **Dissonus** Wilson | 141 |
| *Dissonus kapuri* (Ummerkutty) | 141 |
| *Dissonus furcatus* Kirtisinghe | 143 |
| *Dissonus spinifer* Wilson | 144 |
| *Dissonus ruvetti* Nunes-Ruivo and Fourmanoir | 146 |

| | Page |
|---|---|
| Family PANDARIDAE | 147 |
| Genus **Pandarus** Leach | 149 |
| *Pandarus niger* Kirtisinghe | 151 |
| *Pandarus carcharini* Ho | 153 |
| *Pandarus satyrus* Dana | 157 |
| *Pandarus cranchii* Leach | 159 |
| *Pandarus smithii* Rathbun | 162 |
| Genus **Pseudopandarus** Kirtisinghe | 164 |
| *Pseudopandarus gracilis* Kirtisinghe | 165 |
| *Pseudopandarus longus* (Gnanamuthu) | 168 |
| Genus **Perissopus** Stp. & Lutk. | 170 |
| *Perissopus dentatus* Stp. & Lutk. | 171 |
| Genus **Nesippus** Heller | 174 |
| *Nesippus crypturus* Heller | 175 |
| *Nesippus orientalis* Heller | 179 |
| *Nesippus tigris* Cressey | 182 |
| *Nesippus vespa* Kirtisinghe | 184 |
| Genus **Echthrogaleus** Stp. & Lutk. | 186 |
| *Echthrogaleus coleoptratus* (Guerin) | 188 |
| *Echthrogaleus denticulatus* Smith | 192 |
| *Echthrogaleus pectinatus* Kirtisinghe | 196 |
| Genus **Phyllothereus** Norman | 197 |
| *Phyllothereus cornutus* (M. Edwards) | 197 |
| Genus **Gangliopus** Gerstaecker | 202 |
| *Gangliopus phyriformis* Gerstaecker | 203 |
| Genus **Dinemoura** Latreille | 207 |
| *Dinemoura latifolia* (Stp. & Lutk.) | 208 |
| *Dinemoura descrepans* Cressey | 212 |
| Genus **Pagina** Cressey | 217 |
| *Pagina tunica* Cressey | 217 |
| Family TREBIIDAE | 220 |
| Genus **Trebius** Kroyer | 220 |
| *Trebius exilis* Wilson | 221 |
| *Trebius kirtii* Hameed and Pillai | 223 |
| *Trebius javanicus* Hameed and Pillai | 224 |
| *Trebius sepheni* Hameed and Pillai | 227 |

| | *Page* |
|---|---|
| Family CALIGIDAE | 230 |
| Subfamily CALIGINAE | 232 |
| Genus **Caligus** Muller | 233 |
| *Caligus amblygenitalis* Pillai | 239 |
| *Caligus annularis* Yamaguti | 241 |
| *Caligus arii* Bassett-Smith | 243 |
| *Caligus asymmetricus* Kabata | 245 |
| *Caligus auxisi* Pillai | 247 |
| *Caligus bicycletus* Heegaard | 250 |
| *Caligus bonito* Wilson | 252 |
| *Caligus brevicaudus* Pillai | 255 |
| *Caligus chiloscyllii* (Pillai) | 257 |
| *Caligus chrysophrysi* sp. nov. | 259 |
| *Caligus clavatus* Kirtisinghe | 262 |
| *Caligus confusus* Pillai | 264 |
| *Caligus constrictus* Heller | 267 |
| *Caligus cordyla* Pillai | 269 |
| *Caligus cornutus* Heegaard | 272 |
| *Caligus coryphaenae* Stp. & Lutk. | 274 |
| *Caligus cossacki* Bassett-Smith | 276 |
| *Caligus cybii* Bassett-Smith | 277 |
| *Caligus dakari* van Beneden | 279 |
| *Caligus dasyaticus* Rangnekar | 280 |
| *Caligus diaphanus* Nordmann | 282 |
| *Caligus distortus* Pillai and Natarajan | 285 |
| *Caligus epinepheli* Yamaguti | 287 |
| *Caligus euthynnus* Kurian | 290 |
| *Caligus furcisetifer* Redkar *et al.* | 292 |
| *Caligus hamruri* Pillai | 294 |
| *Caligus holocentri* sp. nov. | 296 |
| *Caligus indicus* Pillai | 298 |
| *Caligus infestans* Heller | 301 |
| *Caligus kanagurta* Pillai | 303 |
| *Caligus lagocephali* Pillai | 305 |
| *Caligus laticaudus* Shiino | 308 |
| *Caligus lobodes* (Wilson) | 309 |
| *Caligus longicaudus* Bassett-Smith | 312 |
| *Caligus longipedis* Bassett-Smith | 314 |
| *Caligus malabaricus* Pillai | 317 |

| | Page |
|---|---|
| *Caligus multispinosus* Shen | 319 |
| *Caligus nengai* Rangnekar *et al.* | 321 |
| *Caligus parapetalopsis* Hameed and Pillai | 323 |
| *Caligus pelagicus* Kurian | 325 |
| *Caligus phipsoni* Bassett-Smith | 328 |
| *Caligus planktonis* Pillai | 330 |
| *Caligus platurus* Kirtisinghe | 332 |
| *Caligus platytarsis* Bassett-Smith | 334 |
| *Caligus polycanthi* Gnanamuthu | 337 |
| *Caligus priacanthi* Pillai | 338 |
| *Caligus productus* Dana | 340 |
| *Caligus quadratus* Shiino | 342 |
| *Caligus raniceps* Heegaard | 345 |
| *Caligus robustus* Bassett-Smith | 345 |
| *Caligus rotundigenitalis* Yu | 348 |
| *Caligus russellii* Kurian | 350 |
| *Caligus savala* Gnanamuthu | 353 |
| *Caligus sciaenae* Gnanamuthu | 355 |
| *Caligus tenax* Heller | 356 |
| *Caligus tylosuri* (Rangnekar) | 358 |
| *Caligus undulatus* Shen and Li | 360 |
| *Caligus unguidentatus* Rangnekar and Murti | 362 |
| *Caligus uruguayensis* Thomsen | 365 |
| Genus **Pseudocaligus** Scott | 367 |
| *Pseudocaligus fistulariae* Pillai | 369 |
| *Pseudocaligus laminatus* Rangnekar | 371 |
| *Pseudocaligus parvus* (Bassett-Smith) | 372 |
| Genus **Parapetalus** Stp. & Lutk. | 374 |
| *Parapetalus hirsutus* (Bassett-Smith) | 376 |
| *Parapetalus longipennatus* Rangnekar | 378 |
| *Parapetalus occidentalis* Wilson | 380 |
| *Parapetalus orientalis* Stp. & Lutk. | 382 |
| Genus **Pseudopetalus** Pillai | 384 |
| *Pseudopetalus dussumieri* (Rangnekar) | 384 |
| *Pseudopetalus caudatus* (Gnanamuthu) | 386 |
| *Pseudopetalus formicoides* (Redkar *et al.*) | 389 |
| Genus **Sciaenophilus** van Beneden | 390 |
| *Sciaenophilus benedeni* (Bassett-Smith) | 391 |
| *Sciaenophilus pharaonis* (Nordmann) | 392 |

| | Page |
|---|---|
| *Sciaenophilus tenuis* (van Beneden) | 394 |
| Genus **Parechetus** Pillai | 396 |
| *Parechetus carangis* (Bassett-Smith) | 398 |
| *Parechetus constrictus* Kirtisinghe | 400 |
| Genus **Synestius** Stp. & Lutk. | 401 |
| *Synestius caliginus* Stp. & Lutk. | 401 |
| Genus **Abasia** Wilson | 403 |
| *Abasia platyrostris* Pillai | 404 |
| Genus **Caligodes** Heller | 407 |
| *Caligodes laciniatus* Heller | 407 |
| Subfamily LEPEOPHTHERINAE | 409 |
| Genus **Hermilius** Heller | 410 |
| *Hermilius pyriventris* Heller | 412 |
| *Hermilius longicornis* Bassett-Smith | 416 |
| *Hermilius helleri* Pillai | 418 |
| *Hermilius tachysuri* Pillai and Natarajan | 420 |
| Genus **Pupulina** van Beneden | 422 |
| *Pupulina minor* M. S. Wilson | 424 |
| *Pupulina brevicauda* M. S. Wilson | 427 |
| Genus **Lepeophtheirus** Nordmann | 431 |
| *Lepeophtheirus brachyurus* Heller | 433 |
| *Lepeophtheirus aesopus* Wilson | 435 |
| *Lepeophtheirus rotundiventris* Bassett-Smith | 436 |
| *Lepeophtheirus spinifer* Kirtisinghe | 436 |
| *Lepeophtheirus longipalpus* Bassett-Smith | 439 |
| *Lepeophtheirus lagocephali* Pillai | 441 |
| *Lepeophtheirus crassus* (Wilson and Bere) | 443 |
| *Lepeophtheirus goniistii* Yamaguti | 446 |
| *Lepeophtheirus latigenitalis* Pillai and Natarajan | 447 |
| *Lepeophtheirus creaseyi* (Cressey) | 449 |
| Subfamily ANURETINAE | 450 |
| Genus **Anuretes** Heller | 453 |
| *Anuretes perplexus* Bassett-Smith | 454 |
| *Anuretes anomalus* Pillai | 456 |
| Genus **Heniochophilus** Yamaguti and Yamasu | 458 |
| *Heniochophilus branchialis* (Rangnekar) | 459 |
| *Heniochophilus indicus* Pillai | 462 |
| Genus **Pseudanuretes** Yamaguti | 464 |
| *Pseudanuretes schmidti* Rangnekar | 465 |

| | Page |
|---|---|
| Genus **Mappates** Rangnekar | 466 |
| *Mappates plataxus* Rangnekar | 467 |
| Family EURYPHORIDAE | 470 |
| Subfamily TUXOPHORINAE | 471 |
| Genus **Tuxophorus** Wilson | 472 |
| *Tuxophorus caligodes* Wilson | 473 |
| *Tuxophorus wilsoni* Kirtisinghe | 475 |
| Genus **Tuxuphoropsis** nov. | 477 |
| *Tuxophoropsis cybii* (Nunes-Ruivo and Fourmanoir) | 477 |
| Subfamily EURYPHORINAE | 478 |
| Genus **Gloiopotes** Stp. & Lutk. | 479 |
| *Gloiopotes watsoni* Kirtisinghe | 481 |
| *Gloiopotes huttoni* (Thomson) | 485 |
| *Gloiopotes hygomianus* Stp. & Lutk. | 486 |
| Genus **Euryphorus** M. Edwards. | 480 |
| *Euryphorus nordmanni* M. Edwards | 490 |
| Genus **Elytrophora** Gerstaecker | 492 |
| *Elytrophora hemiptera* Wilson | 494 |
| *Elytrophora indica* Shiino | 498 |
| Genus **Alebion** Kroyer | 501 |
| *Alebion maculatus* Wilson | 502 |
| *Alebion crassus* Wilson | 506 |
| *Alebion gracilis* Wilson | 510 |
| *Alebion carchariae* Kroyer | 512 |
| *Alebion elegans* Capart | 514 |
| Genus **Paralebion** Wilson | 515 |
| *Paralebion elongatus* Wilson | 516 |
| Family ANTHOSOMATIDAE | 519 |
| Genus **Anthosoma** Leach | 521 |
| *Anthosoma crassum* (Abildgaard) | 522 |
| Genus **Lernanthropus** Blainville | 524 |
| *Lernanthropus abitocephalus* Tripathi | 528 |
| *Lernanthropus alatus* Pillai | 531 |
| *Lernanthropus brevicephalus* Rangnekar | 533 |
| *Lernanthropus cadenati* Delamare-Deboutteville and Nunes-Ruivo | 535 |

| | Page |
|---|---|
| *Lernanthropus chirocentrosus* Tripathi | 538 |
| *Lernanthropus chrysophrys* Shishido | 540 |
| *Lernanthropus corniger* Yamaguti | 541 |
| *Lernanthropus cruciatus* Pillai | 543 |
| *Lernanthropus decapteri* Pillai | 545 |
| *Lernanthropus dussumieri* Gnanamuthu | 547 |
| *Lernanthropus engraulis* Tripathi | 550 |
| *Lernanthropus forficatus* Redkar *et al.* | 551 |
| *Lernanthropus gibbosus* Pillai | 553 |
| *Lernanthropus giganteus* Kroyer | 555 |
| *Lernanthropus indicus* (Pillai) | 558 |
| *Lernanthropus koenigii* Stp. & Lutk. | 560 |
| *Lernanthropus lappaceus* Wilson | 562 |
| *Lernanthropus latis* Yamaguti | 566 |
| *Lernanthropus lativentris* Heller | 568 |
| *Lernanthropus leiognathi* Tripathi | 572 |
| *Lernanthropus nemipteri* Jayasree and Pillai | 574 |
| *Lernanthropus nudus* Bassett-Smith | 577 |
| *Lernanthropus oblongus* Pillai | 577 |
| *Lernanthropus opisthopteri* Pillai | 581 |
| *Lernanthropus otolithi* Pillai | 583 |
| *Lernanthropus pami* Tripathi | 583 |
| *Lernanthropus pristipomoides* Kirtisinghe | 585 |
| *Lernanthropus robustus* Pillai | 586 |
| *Lernanthropus rubiginosus* Redkar *et al.* | 588 |
| *Lernanthropus sciaeni* Gnanamuthu | 589 |
| *Lernanthropus secutoris* Pillai | 591 |
| *Lernanthropus sillaginis* Pillai | 594 |
| *Lernanthropus shishidoi* Shiino | 596 |
| *Lernanthropus sphyraenae* Yamaguti and Yamasu | 598 |
| *Lernanthropus triangularis* Pillai | 599 |
| *Lernantthropus trifoliatus* Bassett-Smith | 601 |
| *Lernanthropus tylosuri* Richiardi | 604 |
| Genus **Lernanthropodes** Bere | 607 |
| *Lernanthropodes trachinoti* Pillai | 608 |
| *Lernanthropodes chorinemi* Pillai | 610 |
| Genus **Aethon** Kroyer | 612 |
| *Aethon globosus* (Pillai) | 614 |
| *Aethon priacanthi* (Kirtisinghe) | 616 |

| | Page |
|---|---|
| Genus **Sagum** Wilson | 618 |
| *Sagum epinepheli* (Yamaguti and Yamasu) | 620 |
| *Sagum enneacentri* sp. nov. | 623 |
| *Sagum tuberculatum* sp. nov. | 626 |
| Family EUDACTYLINIDAE | 629 |
| Genus **Eudactylinopsis** Pillai | 630 |
| *Eudactylinopsis curvatus* Pillai | 631 |
| Genus **Bariaka** Cressey | 635 |
| *Bariaka alopiae* Cressey | 636 |
| Genus **Eudactylina** van Beneden | 639 |
| *Eudactylina aspera* Heller | 640 |
| *Eudactylina pusilla* Cressey | 642 |
| *Eudactylina pollex* Cressey | 645 |
| *Eudactylina olivieri* Laubier | 647 |
| *Eudactylina alata* Pillai | 651 |
| *Eudactylina lancifera* Pillai | 654 |
| Genus **Nemesis** Risso | 657 |
| *Nemesis aggregatus* Cressey | 658 |
| *Nemesis lamna* Risso | 662 |
| *Nemesis robusta* (van Beneden) | 664 |
| *Nemesis versicolor* Wilson | 668 |
| Genus **Kroyeria** van Beneden | 670 |
| *Kroyeria dispar* Wilson | 671 |
| *Kroyeria gemursa* Cressey | 674 |
| *Kroyeria gracilis* Wilson | 677 |
| *Kroyeria spatulata* Pearse | 681 |
| *Kroyeria longicauda* Cressey | 683 |
| *Kroyeria echinata* Rangnekar | 686 |
| *Kroyeria sphyrnae* Rangnekar | 688 |
| *Kroyeria minuta* Pillai | 690 |
| Family PSEUDOCYCNIDAE | 692 |
| Genus **Pseudocycnus** Heller | 694 |
| *Pseudocycnus appendiculatus* Heller | 695 |
| *Pseudocycnus armatus* (Bassett-Smith) | 697 |
| Family DICHELESTHIIDAE | 700 |
| Genus **Hatschekia** Poche | 701 |
| *Hatchekia pholas* (Wilson) | 702 |
| *Hatchekia ovalls* (Bassett-smith) | 704 |
| *Hatchekia foliata* Redkar *et al.* | 706 |

| | Page |
|---|---|
| *Hatschekia sphyraeni* Pillai | 708 |
| *Hatschekia elliptica* Pillai | 709 |
| *Hatschekia caudata* sp. nov. | 711 |
| Genus **Pseudocongericolo** Yu | 713 |
| *Pseudocongericola chefoonensis* Yu | 714 |
| Family LERNAEOCERIDAE | 714 |
| Genus **Lernaeenicus** Le Sueur | 716 |
| *Lernaeenicus hemirhamphi* Kirtisinghe | 717 |
| *Lernaeenicus ramosus* Kirtisinghe | 719 |
| *Lernaeenicus nemipteri* Gnanamuthu | 721 |
| *Lernaeenicus stromatei* Gnanamuthu | 722 |
| *Lernaeenicus sayori* Yamaguti | 723 |
| *Lernaeenicus alatus* Rangnekar | 723 |
| *Lernaeenicus longiventris* Wilson | 724 |
| *Lernaeenicus seeri* Kirtisinghe | 725 |
| *Lernaeenicus polynemi* (Bassett-Smith) | 725 |
| *Lernaeenicus anchoviellae* Subastian and George | 726 |
| Genus **Cardiodectes** Wilson | 727 |
| *Cardiodectes anchorellae* Brian and Gray | 727 |
| *Cardiodectes krishnai* Sebastian | 728 |
| Genus **Peniculus** Nordmann | 729 |
| *Peniculus trichiuri* Gnanamuthu | 729 |
| *Peniculus theraponi* Gnanamuthu | 731 |
| *Peniculus sciaeni* Gnanamuthu | 731 |
| *Peniculus stromatei* Gnanamuthu | 732 |
| *Peniculus scomberi* Gnanamuthu | 733 |
| Genus **Peniculisa** Wilson | 733 |
| *Peniculisa furcata* (Kroyer) | 734 |
| *Peniculisa wilsoni* Radhakrishnan | 735 |
| Genus **Lernaeolophus** Heller | 737 |
| *Lernaeolophus sultanus* (Nordmann) | 738 |
| Genus **Pennella** Oken | 740 |
| *Pennella robusta* Gnanamathu | 741 |
| *Pennella platycephala* Gnanamuthu | 742 |
| *Pennella elegans* Gnanamathu | 742 |
| *Pennella longicauda* Gnanamuthu | 743 |
| *Pennella instructa* Wilson | 744 |
| *Pennella biloba* Kirtisinghe | 745 |
| *Pennella diodontis* Oken | 745 |

| | Page |
|---|---|
| *Pennella selaris* Kirtisinghe | 746 |
| Genus **Peroderma** Heller | 746 |
| *Peroderma cylindricum* Heller | 747 |
| Suborder *LERNAEOPODOIDA* | 748 |
| FAMILY LERNAEOPODIDAE | 748 |
| Subfamily LERNAEOPODINAE | 750 |
| Genus **Lernaeopoda** Blainville | 750 |
| *Lernaeopoda upenei* Pillai | 751 |
| *Lernaeopoda stromatei* Gnanamuthu | 753 |
| *Lernaeopoda scoliodontis* Kirtisinghe | 755 |
| Subfamily CLAVELLINAE | 757 |
| Genus **Thysanote** Kroyer | 758 |
| *Thysanote appendiculata* (Stp & Lutk.) | 759 |
| *Thysanote longimana* Wilson | 762 |
| *Thysanote multifimbriata* (Bassett-Smith) | 764 |
| *Thysanote furcata* Kirtisinghe | 766 |
| *Thysanote heterodactyla* Kirtisinghe | 766 |
| *Thysanote rastrelligeri* Rangnekar | 767 |
| *Thysanote eleutheronemi* Rangnekar | 768 |
| Genus **Pseudocharopinus** Kabata | 770 |
| *Pseudocharopinus narcinae* (Pillai) | 772 |
| *Pseudocharopinus kabatai* new name | 773 |
| *Pseudocharopinus dasyaticus* (Rangnekar) | 776 |
| Genus **Charopinopsis** Yamaguti | 778 |
| *Charopinopsis quaternia* (Wilson) | 779 |
| Genus **Brachiella** Curvier | 781 |
| *Brachiella albida* (Rangnekar) | 782 |
| *Brachiella trichiuri* Gnanamuthu | 784 |
| *Brachiella thynni* Cuvier | 787 |
| *Brachiella lutiani* (Pillai) new name | 789 |
| *Brachiella otolithi* Pillai | 792 |
| Genus **Clavellisa** Wilson | 793 |
| *Clavellisa obchordata* Rangnekar | 794 |
| *Clavellisa dussumieriae* Gnanamuthu | 796 |
| *Clavellisa hilsae* Tripathi | 798 |
| *Clavellisa pellonae* Tripathi | 800 |
| *Calvellisa phasa* Tripathi | 802 |

| | *Page* |
|---|---|
| Genus **Isobranchia** Heegaard | 803 |
| *Isobranchia appendiculata* Heegaard | 804 |
| Genus **Proclavellodes** Kabata | 806 |
| *Proclavellodes pillaii* Kabata | 807 |
| Genus **Clavellopsis** Wilson | 809 |
| *Clavellopsis Bilobata* Pillai | 809 |
| | |
| Family SPHYRIIDAE | 812 |
| Genus **Paeoti** Wilson | 812 |
| *Paeon lobatus* Kirtisinghe | 813 |
| Genus **Tripaphylus** Richiardi | 814 |
| *Tripaphylus hemigalei* Kirtisinghe | 814 |

# INTRODUCTION

Early carcinologists have described a few copepod parasites collected from fishes inhabiting the Indian waters. But the first important work on the fauna of the Indian ocean is that of Bassett-Smith (1898). He described several copepods collected from the Arabian Sea and the Persian Gulf. As his illustrations are very inadequate, recognition of some of his species is even now difficult. Fortunately most of them have been redescribed satisfactorily.

After a lapse of about thirty years Kirtisinghe (1932-1964) began studying the copepods of the Ceylon waters. His efforts culminated in a useful review of the literature on the copepod fish parasites of Ceylon.

The study of the Indian fauna was taken up by Gnanamuthu (1947-1957) and Rangnekar (1953-1963). Gnanamuthu studied the copepods of the Bay of Bengal and Rangnekar those of the Arabian sea. They made significant addition to our knowledge of the Indian fauna.

I began studying the copepods of the coastal waters of Kerala in 1961. Within a short time I was able to collect a majority of the species previously recorded from this locality. These were described in a series of publications (Pillai, 1961-1977).

Recently Cressey (1967b) described a rich collection of copepods parasitic on elasmobranchs inhabiting the off-shore waters of the Indian ocean. This work is particularly important since all the previous work dealt with parasites of shallow water fishes. Cressey's revisions of the Pandaridae (Cressey, 1967a) and *Alebion* (Cressey, 1972) are particularly useful.

Useful information on the Indian fauna is available in the publications of Redkar *et al.* (1949), Rao (1950-1951), Kurian (1949-1951), P. G. Rangnekar (1950-1964), Tripathi (1962), Sebastian (1964-1968), Bennet (1961-1974) and Hameed and Pillai (1972-1973). The numerous publications of Wilson, Heegaard, Shiino, Kabata

Ho, Lewis and Hewitt contain excellent descriptions of many species occurring in Indian waters and are indispensable for any study on the Indian fauna.

My primary aim in agreeing to write this volume was to bring together in one publication the scattered information on the Indian fauna and as far as possible provide original illustrations of all species. I, therefore, requested individuals and institutions to send material in their possession. The response from abroad was very good but nearer home it was disappointing. I particularly thank Dr. Cressey, Smithsonian Institution, Washington and Professor Shiino, Japan, for sending valuable material.

The available descriptions of many species created by Kirtisinghe, Gnanamuthu and Rangnekar are unsatisfactory for inclusion in a monographic study. But as the material could not be obtained I was compelled to depend on published information.

My own study of the copepod parasites of fishes has shown that the Indian fauna is very rich and that many more species await discovery. This publication, providing information on all the species so far recorded, I hope, will stimulate further work on this extremely common and highly interesting group of fish parasites.

I am grateful to the Director, Zoological Survey of India, Calcutta, for giving me the opportunity to make this study and to the Syndicate of the University of Kerala for permitting me to undertake the same. I sincerely thank Dr. N. Balakrishnan Nair, the head of my department for the various helps rendered during the course of this work.

## FAUNAL BOUNDARY

Previous volumes in the "Fauna of India" series, except that on Polychaeta (Fauvel, 1953), dealt with terrestrial or fresh-water animals. Delimiting the faunal boundary was therefore comparatively easy. As observed by Fauvel this is difficult in the case of marine animals since many of them are cosmopolitan in distribution. Recent studies by Cressey (1967b) have shown that

elasmobranch parasites have circumtropical distribution. For the present work the southern limit is fixed at 20° south of the equator which would roughly correspond with the 75° F isotherm. African and Arabian coasts provide a convenient western boundary. The eastern boundary is arbitrarily fixed at 15° longitude. The area thus delimited can be described as the warm water region of the Indo-West Pacific which is a recognised faunestic region (Ekman, 1953).

## COLLECTION, EXAMINATION AND PRESERVATION OF SPECIMENS

### Collection

Copepode are parasitic on almost every kind of surface-living and shallow-water fish. They are comparatively few in mid-water fishes and very rare in deep-sea fishes. This is because the possibility of infection by the free-swimming larvae is greatest in the shallow sunlit waters.

Bomolochids and taeniacanthids are comparatively small and have to be carefully searched for. But they are quite often present in good numbers on the inner surface of the opercle and on the gills. The opaque egg sacs reveal the presence of the females but the small males are quite invisible because of their transparency. Flushing the opercular chamber by squirting water with a dropper would wash out the males and can be easily picked up.

Bomolochids are known to live in the nasal cavities of fishes. But recently an interesting group of highly specialised species has been found living under the adipose eye-lids of clupeids in the Indo-Pacific.

Chondracanthids are generally small and infest the gills, particularly of flat fishes and platycephalids living in comparatively shallow waters. They show an apparent preference for demersal fishes.

Caligids are very common on the body surface, inner surface of the opercle, on the gill arches and in the buccal cavity of all

kinds of fishes. Those inhabiting the buccal and branchial cavities will remain where they are even after the death of the host. But those on the body surface may drop off during the death struggle of the host or get rubbed off while the hosts are handled. If possible fishes should be examined soon after they are caught.

Pandarids are gregarious and usually occur in large numbers especially on the fins. They also inhabit the nasal cavities, spiracles, cloacal aperture and the gills.

Gill parasites like anthosomatids, eudactylinids and dichelesthiids are comparatively small and their colour matches that of the gill filaments. The best method to collect them is to cut out the gills and tease them in a petri dish with a needle. The parasites can then be picked up under a binocular microscope. I have found this method particularly suitable for collecting *Hatschekia*, *Lernanthropus*, *Kroyeria* and *Eudactylina*. But this cannot be easily done in the field.

Lernaeocerids remain deeply burried in the body of the host. The complete parasite can be taken out only by cutting open the body of the host. Without the head it is impossible to identify them.

Lernaeopodids remain exposed but cemented to the body of the host with the help of a bulla. The bulla has taxonomic value and hence should be kept in tact. It is better to cut the host tissue around the bulla which can be leisurely cleaned in the laboratory. Lernaeopodids are usually found on the wall of the buccal cavity, branchial cavity and also on the gill arches.

Till recently studies on parasitic copepods were mostly taxonomic. But biological and zoogeographical studies are being taken up. For such work correct identification of the host is essential. As this can be properly done only by a specialist the hosts may be preserved for study by the specialist provided the fishes are of suitable size.

Much of what has been stated above cannot be easily done in the field. Large host-fishes cannot be taken to the laboratory

This unfortunately is a handicap in the collection of parasitic copepods.

## Preservation

Copepod parasites are invariably covered by mucus secreted by the host. All sorts of dirt may be adhering to the mucus. If the parasites are transferred directly to the preservative the mucus would harden and stick on the parasite making its subsequent study difficult. Very small specimens preserved like this will be useless.

Before preserving, the copepods may be kept immersed for fifteen minutes in a weak solution of sodium bicarbonate. The mucus can then be easily removed by squirting water over them through a dropper. Even common salt available everywhere can be substituted for this purpose. The collection can also be transported to the laboratory in a thermos flask and the cleaning leisurely done there.

The ideal preservative for all copepods is alcohol. But alcohol is volatile and care should be taken during transportation and storage. More over alcohol is costly and may not always be available in sufficient quantity.

Formalin has the advantage that it is cheap and less volatile. As it can be diluted only small quantities need be taken when you go out for collecting. But commercial formalin has a corrosive action and dissolves out fine cuticular structures which can have taxonomic value. Hence if you must, only adequately treated formalin should be used. Formalin acts on cork producing a dark stain which blackens the material. Hence cork should not be used when the preservative is formalin. The tube can be plugged with cotton and kept immersed in a bottle filled with the same preservative.

Details of collection should be written on good quality paper with pencil, preferably with Indian ink, and placed within the tube or bottle. Accidental change of label can create complications.

### Examination

Preservation is bound to create some distortion, greater in the case of soft bodied species. Those with thick or rigid body will have to be cleared for studying the various appendages. The most suitable method is to place the specimen if small, in one or two drops of lactic acid. In about fifteen minutes the specimen would fully relax regaining its original shape. Large specimens can be kept immersed in lactic acid for a longer period. Besides making the specimen relax lactic acid would clear the material and also soften the muscles facilitating the removal of the appendages. Dorso-ventrally flattened copepods like *Caligus* can be adequately studied without dissecting. This may be particularly advantageous when you have only one specimen or the specimen is otherwise important and should be kept intact.

In addition to being a good clearing fluid lactic acid has other advantages. As it is not volatile temporary mounts can be left over for subsequent examination. The only defect lactic acid has is that it destroys the internal tissues. But this is of no consequence unless one is interested in anatomical study of the material.

It has been the practice of even well known carcinologists to make permanent mounts of their material. This is undesirable as mounting is sure to distort the specimen. Overlapping of the appendages would make their detailed study difficult.

Many workers use stains for examining the appendages. Suitable staining may be advantageous. But I have found that even minute details can be observed without staining.

## MORPHOLOGY

### Body

Copepods are abundant everywhere in the sunlit waters of the marine habitat. This is not surprising since they act as connecting link between the autotrophic organisms and the carnivores. Recent studies have revealed that copepods live in association with almost every group of metazoa. These associations vary from simple

"living together" without undergoing any morphological change to complete endoparasitism accompanied by loss of all crustacean characters. In variety only terrestrial insects rival copepods.

Copepods parasitic on fishes belong to Cyclopoida, Caligoida and Lernaeopodoida. Cyclopoids (barring chondracanthids and a few specialised genera) are least modified and lernaeopodoids most modified. Caligoids occupy an intermediate position.

Cyclopoids generally have a fully segmented body demarcated into a broad fore-body and a narrow hind-body. But species belonging to the genera *Telson*, *Scolecicara*, *Therodamas*, *Paeonodes*, *Mugilicola* and *Lernaea* have an elongated worm-like body. Chondracanthids have a variety of shapes due to the presence of body processes of unknown homology.

Caligids show diverse types of body form. In *Caligus* the cephalon is fused with the first three thoracic segments to form a nearly circular dorso-ventrally flattened cephalothorax. The genital segment is swollen and united with the cephalothorax through a waist-like fourth segment. The abdomen is generally short and slender. This shape is characteristic of *Lepeophtheirus* and *Anuretes* also. But deviations from this pattern are very common. In *Parapetalus* and *Abasia* the genital segment is flattened or produced into large wings. In *Synestius*, *Caligodes* and *Paralebion* the genital segment is produced into long processes. In *Sciaenophilus*, *Parechetus* and *Caligodes* the fourth and genital segments are partially fused and the whole drawn out into a long neck. With the increase in the size of the hind-body there is often a decrease in the size of the cephalothorax.

Another line of development is the progressive suppression of the abdomen. This is evident in a few species of *Caligus* and *Lepeophtheirus*, many species of *Anuretes* and in all species of *Heniochophilus*, *Pseudanuretes* and *Mappates*. In the last three genera the suppression of the abdomen is associated with a progressive increase in the size of the postero-median lobe of the cephalothorax which in *Mappates* almost fully covers the genital segment. Notwithstanding all these changes in the female the males of all the genera retain the fundamental caligid shape.

Euryphorids generally resemble caligids but the genital segment may have small or large lobes and the fourth segment is always covered by a pair of dorsal plates. In dissonids and pandarids there are three free thoracic segments and in trebiids two. While all the others retain the typical caligid shape pandarids differ much due to the development of dorsal plates on the thoracic segments. Though pandarids exhibit unusual homogenity the difference in the arrangement of the plates has produced a variety of shapes.

Gill infesting parasites of the families Pseudocycnidae, Eudactylinidae and Dichelesthiidae have an elongated cylindrical body demarcated into cephalothorax and an unsegmented trunk. However in *Eudactylina*, *Nemesis* and *Kroyeria* the body is fully segmented and carries the normal compliment of legs though they are not functional.

Lernaeocerids are worm-like unsegmented copepods remaining deeply burried in the body of the host. For anchoring themselves they have developed cephalic processes ranging from simple horns (*Lernaeenicus*) to a grotesque branching mass of tubular growths (*Phrixocephalus*).

Copepod parasites generally exhibit sexual dimorphism. In cyclopoids this is evident mainly in the enormous development of the maxillipeds in the male. Caligid males have small genital segment and fully segmented slender abdomen. The antennae and maxillipeds have additional armature. Pandarid males show great uniformity and the males of various genera were once thought to belong to the genus *Nogagus*.

Males of chondracanthids and lernaeopodids are so degenerated that they can live only in association with the female. Ontogenic study has revealed that the adult male is really the last larva slightly modified. This is to some extent true of the males of other families also, but they have an idependant existence.

Unlike the females the males of parasitic copepods are capable of moving about and are less subjected to the environmental influence. They therefore retain the typical body form.

## Appendages

There has been much discussion on the homology of the appendages of copepods (Heegaard, 1947a ; Lang, 1947 ; Lewis, 1969). The question is ostill somewhat pen.

The first three appendages are the antennules (first antennae), antennae (second antennae) and the mandibles. These are represented in the nauplius and there is no dispute about them. The antennule is typically a cylindrical, multijointed setose appendage but has undergone modification to serve specific functions. Thus in caligids this appendage is flattened to help the cephalothorax which functions as an adhesive organ. The same applies to bomolochids and taeniacanthids. But in those copepods which have a cylindrical body and the cephalothorax does not act as an adhesive organ the antennule is slender and elongated.

The antenna is invariably a prehensile organ showing some variation. In cyclopoids it is three or four-segmented, in caligids three-jointed, in eudactylinids four-jointed, in anthosomatids two-jointed and in lernaeopodids indistinctly jointed and apparently biramous. In *Kroyeria* this appendage is chelate. The distal segment of the antenna in caligids has an indistinct partition carrying a spinule. The antenna therefore may be typically a four-jointed appendage. The antenna shows pronounced sexual dimorphism, particularly in *Lepeophtheirus*. This is the organ which helps the male to hold on to the female during pairing.

Except in cyclopoids the mandible is an indistinctly jointed stylet carrying a few apical teeth. In a few lernaeocerids it is much reduced. In cyclopoids it is a two-jointed chitinised structure, the distal joint bilaterally serrated in chondracanthids but carrying two blades in bomolochids and taeniacanthids.

All the controversy centres round the next two pairs of appendages namely the maxillules (first maxilla) and maxillae (second maxilla). Outer to the tip of the antennae there is in caligids a small chitinised claw (occasionally much reduced or absent) carrying on its base two bunches of hairs. Till recently this was described as the maxillule. But after studying the development of *Lepeophtheirus dissimulatus* Lewis (1963) observed that it is a

cuticular process and not an appendage. He designated this as post-antennal process, a truly non-controversial term.

Outer to the base of the oral cone is a chitinised triangular process associated with a tubercle carrying three setae. This was till recently described as the maxilla. But Lewis (1967) observed that the process and the nodule have independent origin. He considered the nodule as representing the maxillule and the chitinous process was designated as post-oral process. There is some justification in this because even when the process is ill-developed or absent the nodule is present. But in *Dissonus* the post-oral process actually carries the nodule. It is therefore more reasonable to consider both as constituting the maxillule.

The post-antennal and post-oral processes are characteristic of caligids and euryphorids. Homologous structures are present in dissonids, trebiids and pandarids. It is doubtful whether they can be dismissed as mere cuticular structures. They are obviously serving some important function. Otherwise they would not have occurred with such regularity in many genera. At least in the male of some species of *Caligus* the post-antennal process must assist the antennae in holding on to the female. For example in *Abasia* the female lacks the post-antennal process while it is well developed in the male. It seems that the final word has not yet been pronounced regarding the homology of these two structures.

In caligids, pandarids, euryphorids, dissonids and trebiids, just behind the post-oral process is a two-jointed appendage carrying two distal claws and an outer distal thin flange. According to Lewis the maxillary gland opens at the base of this appendage. This must, therefore, be the maxilla and the stout prehensile appendage following this the maxilliped. Wilson, Heegaard and Shiino used to describe the two pairs of post-oral appendages as maxillipeds but Lang (1948) observed that copepods have only one pair of maxillipeds. If the nomenclature proposed by Lewis is accepted copepods will have a pair of antennules, antennae, mandibles, maxillules, maxillae and maxillipeds. This seems to be logical since in all copepods except *Hatschekia* and lernaeocerids there are appendages corresponding to all the above mentioned, while the counterpart of the post-antennal process is not present.

In cyclopoids the maxillule is a small lobe carrying three to four setae. In anthosomatids, eudactylinids and dichelesthiids it is bilobed, each lobe carrying apical spines. In pandarids it is a flattened lobe carrying small spines and in lernaeopodids it has a stout stem with two to three processes and a palp.

The maxilla is basically a two-jointed appendage except in cyclopoids and lernaeopodids. In the former it is a large chitinised structure carrying one or two apical serrated blades while in the latter a highly mobile cylindrical muscular organ serving for attachment. In caligids the maxilla ends in two apical claws but in pandarids there are three apical elements. The third structure is apparently homologous with the outer flange seen in caligids. In some euryphorids the outer flange is already a strong serrated lobe. A different pattern of armature is evident in anthosomatids, dichelesthiids and eudactylinids.

The maxilliped is a two-or three-jointed chelate or sub-chelate prehensile appendage showing much variation in armature. In cyclopoids it is distinctly three-jointed but in others apparently two-jointed. But what appears to be the remnant of a third joint is visible. In *Hatschekia*, behind the maxillule only one appendage is present. This is described as the maxilliped. From its shape and position it appears to be the maxilla. If so the maxilliped is lacking in *Hatschekia* and lernaeocerids.

There is some diversity of opinion regarding the number of segments in various appendages. As already stated the antennule is multi-jointed and the antenna typically four-jointed. Cressey has described the maxilla of pandarids as three-jointed. This may be so as an indistinct partition is usually visible at the base of the median claw. As a similar partition is present in caligids the maxilla of caligids also should be considered as three-jointed. The maxilliped is apparently only two-jointed but as in the antenna there are indications of four segments.

In caligids, just behind the maxillipeds, there is a forked chitinised structure called the sternal fork. Its homology and function are still not clearly understood (Lewis, 1966 a.). The sternal fork is supposed to act as a prop preventing backward slipping

of the parasite. Against this view it is contented that the sternal fork is so small that even when fully erected it cannot contact the body surface of the host. Nevertheless the sternal fork has some taxonomic value.

Proportional to the modification the parasite has undergone the thoracic appendages show reduction ending in their absence. In the least modified bomolochids and taeniacanthids they are biramous, with two-jointed protopod and three-jointed rami. In others various degrees of reduction have occurred. In chondracanthids the legs are reduced to mere lobes. In anthosomatids they are foliaceous lobes and in pandarids elytra-like. But in the highly modified lernaeocerids and in dichelesthiids and eudactylinids they are typical biramous setose appendages though they have no locomotory function.

Among caligids the first and fourth legs have undergone much reduction. The fourth leg lost its function as the third legs formed an apron to aid the cephalothorax in adhesion. This created a barrier and the fourth leg lost its original function and consequently got reduced. Its reduction has steadily progressed and culminated in its total suppression as in *Pseudocaligus*. But the reduction in the first leg is curious. Perhaps this leg situated in the centre of the cephalothorax is no more able to contact the body surface of the host. If so why the elaborate armature of its basipod and the distal exopod segment ? We simply cannot explain many of the features of parasitic copepods. Morphological variations in the thoracic appendages of copepod parasites are legion and cannot be easily explained.

## HOST-PARASITE RELATIONSHIP

It is not my intention to enter into any detailed discussion on the various aspects of the host-parasite relation among copepods. As observed by Kabata (1970a) next to nothing is known about the biology and the factors regulating the relationship of copepods with their hosts.

Recently Cressey and Collette (1970) studied the host-parasite relationship among needle fishes. Kabata (1970a) summarised

the available information on the effect of the parasites on the host. In the light of these two publications certain observations made during the present study are discussed.

## Host-specificity

Early carcinologists believed that a particular species of parasite will be found only on a particular species of host. Consequently every parasite discovered on a host previously not known to harbour any was described as new. As taxonomic knowledge on both hosts and parasites increased it became evident that host-specificity as conceived earlier does not exist. Nevertheless every parasite shows some sort of preference for a particular host.

Baer (1952) observed that the host is to the parasite what the biotope is to the free-living organism. He further compared the host to an island and the parasite to the insular fauna. Parasitic copepods are ecologically segregated upon their hosts. The morphological changes necessary for maintaining their hold on the host and the physiological adaptations consequent on the specialised mode of feeding have made this association very intimate. This is particularly so in the case of specialised parasites. This is what has produced host-specificity. Host specificity is a product of evolution and cannot be easily changed. Host-specificity as understood now means that a parasite always occurs in or on one and the same species of host or on hosts more or less directly related either phylogenically or ecologically.

Some species of copepods like *Caligus coryphaenae*, *C. bonito*, *C. quadratus*, *C. productus*, *Perissopus dentatus*, *Euryphorus nordmanni* and *Anthosoma crassum*, to mention a few, are parasitic on a large number of hosts. But a careful scrutiny of the host records and the frequency and intensity of occurrence of the parasite shows that there is a distinct preference for one species of host or closely related hosts. Given the choice the parasite would infest only the preferred host eventhough it may be able to survive on others. Thus at the species level there is host-specificity though not always very strict.

Host-specificity is more marked at the genus level and very pronounced at the family level. Whole families are exclusively

parasitic on particular groups of hosts. The very few stragglers reported in such families are often wrong records or accidental occurrences. Specificity at higher levels is biologically more significant.

Copepod parasites of fishes can be divided into two groups, those parasitic on elasmobranchs and those on teleosts. There is a third group, comparatively unimportant, that can parasitise both elasmobranchs and teleosts. Pandarids and eudactylinids are exclusively elasmobranch parasites. Bomolochids, dicheles-thiids, pseudocycnids and lernaeocerids are teleost parasites. Taeniacanthids, caligids, chondracanthids, cecropids, euryphorids, trebiids, dissonids, anthosomatids and lernaeopodids are found on both elasmobranchs and teleosts.

The above list would appear to indicate that the third group is far more important than the others. A closer scrutiny will show that this is far from so. Among taeniacanthids only very few are parasites of elasmobranchs. In the very large family Caligidae genus *Pupulina* and a few species of *Caligus* and *Lepeophtheirus* alone are parasitic on elasmobranchs. *Anthosoma crassum* is the only anthosomatid parasitic on elasmobranchs. A few species of *Lernaeopoda* and the members of the genus *Charopinus* (before revision) are elasmobranch parasites. It is perhaps significant that *A. crassum* is very much different from all the other anthosomatids. It is very doubtful whether *Pupulina* can be retained within Lepeophtherinae. Among the five genera into which Kabata (1964c) divided the old genus *Charopinus*, *Charopinopsis* alone is parasitic on teleosts. Members of this genus have very little in common with those of the other four genera. Elasmobranchs and teleosts indeed have very distinct groups of parasites.

There are several remarkable instances of strict host-specificity at the genus level. The bomolochid genera *Pseudorbitacolax*, *Pumiliopes* and *Pumiliopsis* are parasites of clupeids. All the known species of *Pseudopetalus* are parasites of clupeids. *Sciaenophilus* shows a distinct perference for sciaenids. *Hermilius* is confined to cat fishes, *Abasia* to lizzard fishes, *Gloiopotes* (except *Gloiopotes hygomianus*) to sail fishes, *Caligodes* to bill fishes, *Pseudocycnus* to scomberoids and *Pupulina* to devil rays. Many more instances of host-specificity can be pointed out.

## Effect of hosts on parasites

In response to the microhabitat conditions available on or in the host parasites undergo modifications, both morphological and physiological. Physiological adaptations are not properly understood because of inherent difficulty in studying them. On the other hand morphological adaptations can be easily seen.

Cressey (1967a) pointed out certain adaptive modifications among pandarids. Among pandarid copepods *Phyllothereus* and *Gangliopus* are found only on the gills. For a parasite inhabiting the gills adhesion pads are useless and appropriately in these two genera they are much reduced. On the other hand the third segment of the antenna is a well developed claw giving them a firm hold on the slippery gill filaments.

Cressey (1967a) divided pandarids into two groups. Of the genera forming the fitst group *Pandarus*, *Pseudopandarus* and *Pannosus* live on the body surface and their maxillipeds have spatulate distal segment. This helps them to have a firm hold on the placoid scales. *Phyllothereus* and *Gangliopus* are gill parasites and in them the third segment of the maxilliped is dactyliform. These two genera of gill infesting pandarids closely resemble each other and stand apart from the rest.

*Hermilius* provides a classical example of morphological changes resulting from habitat shift. As this typical caligid has taken up life on the gill filaments its cephalothorax got folded along the middle and closes on the gill filaments like the shell of a bivalved mollusc. The antenna has its third segment modified into a strong hook exactly similar to that of *Phyllothereus*, with a stout accessory claw which may strengthen its grip. The maxillipeds are also long and slender.

As a rule copepods parasitic on elasmobranchs show strong chitinisation of the body and the prehensile appendages. This is easily seen in pandarids and eudactylinids and especially in *Pupulina*, *Anthosoma* and *Paralebion*. More interesting in this context are genera like *Caligus* and *Lepeophtheirus* which are predominantly teleost parasites. The few members recorded from

elasmobranchs (*C. dasyaticus* Rangnekar and *C. furcisetifer* Redkar *et al.*) show this extra chitinisation.

The site of attachment appears to determine the shape of the body of the parasite. All gill infesting parasites like *Hatschekia*, *Kroyeria*, *Eudactylina* and *Pseudocycnus* have slender cylindrical body. Anthosomatids and *Nemesis* are exceptions. Those living on the surface of the body or opercle have a dorso-ventrally flattened body. But caligids like *Abasia*, *Pseudopetalus*, *Caligodes*, *Parechetus* and *Sciaenophilus* living in the mouth or throat have the postcephalothoracic part of their body enormously enlarged. In these the cephalothorax shows a corresponding reduction in size and can no more provide effective attachment. Appropriately their maxillipeds show disproportionate enlargement. These parasites remain virtually anchored by the maxillipeds.

A few instances of adaptive convergence induced by the hosts were observed during the course of my studies. Along with species of *Hermilius* are found *Caligus arii* Bassett-Smith and *Lepeophtheirus longipalpus* Bassett-Smith. Though these species belong to three genera they show remarkable identity in many of the characters. This identity is particularly evident in the first leg which shows unusual characters. It is significant that this was found true of *Caligus distortus* a parasite of cat fishes.

More than thirty species belonging to the genera *Caligus*, *Parapetalus* and *Parechetus* have been recorded from carangid fishes. They show very wide difference in the shape of the body. Yet all possess a combination of characters which proclaims that they are all parasites of carangids.

From the body surface of *Chorinemus lysan* I collected *Caligus tylosuri* (Rangnekar), *Lepeophtheirus spinifer* Kirtisinghe and *Tuxophorus wilsoni* Kirtisinghe. These three species belonging to different genera have identical cephalothorax and in all the fifth leg is modified into chitinised processes. The males of *T. wilsoni* and *L. spinifer* are so similar that they are quite indistinguishable except for the absence of lunules in the latter. The antennae of the males of these two species are exact duplicates.

From the chaetodontid fish *Platax teira*, inhabiting Indian waters, have been collected *Heniochophilus branchialis* (Rangnekar), *H. plataxus* Pillai, *Anuretes anomalus* Pillai, *Pseudanuretes schmidti* Rangnekar and *Mappates Paltaxus* Rangnekar. They are so much alike in the shape of the body and the structure of the appendages that they can be distinguished only by a few negative characters.

The few examples mentioned above can only be explained as adaptive convergence induced by the surface characteristics of the host.

## Effect of parasite on the host

Parasitism is an association in which the host provides the parasite with substances that it has elaborated and are essential for the parasite's nutritional requirements. The parasite has lost to some extent the ability to synthesise certain vital substances and must rely on the host to furnish them. Hence it is inevitable that the parasite must do some harm to the host though the nature and extent of the damage caused varies, quite often not apparent.

As observed by Kabata (1970a) next to nothing is known about the eflect of crustacean parasites on their hosts. This is mainly because there are many difficulties. We do not know what exactly is the condition of a normal healthy fish. In all studies conducted so far a fish that does not carry a parasite is considered as healthy and another that carries one as diseased. But it is quite possible that the supposed healthy fish till recently had a parasite and has not fully recovered from the effect of parasitism. Again most studies on fish parasites took into consideration only the particular species of parasite with which one was concerned at the moment whereas the fish had a complex of both internal and external parasites.

Notwithstanding all these difficulties certain general conclusions have been arrived at regarding the harmful activities of copepod parasites. Interested persons may consult Kabata's (1970a) excellent book on the subject.

The gills are a favourite site for the attachment of several copepod parasites. Copepods damage the gills by feeding on the delicate

tissue of the gill lamellae or on the blood circulating within the lamellae. The presence of the parasite always stimulates reaction which is in the nature of hypertrophy of the epithelium and connective tissue. This defensive mechanism turns out to be very harmful since it results in reduction of the respiratory surface. The damage done is calculated to be substantial when the number of parasites is large.

The body of the fish is covered by a thin epithelium which is not a protective tissue. Any parasite that can hold on to the body can brouse on the surface or feed on the mucus or puncture the skin and suck blood. The attack on the skin initiates defensive action in the form of deposition of connective tissue around the site of infection as an attempt to isolate the intruder. This may be successful when the parasite is permanently attached but cannot work against those like *Caligus* which can move about.

A few cyclopoids are known to inhabit the space between the cornea and adipose eye-lids of clupeids. They are not known to cause any damage. But lernaeocerids like *Phrixocephalus* and *Lernaeeicus sprattae* attack the eye ball and may produce total blindness.

Lernaeocerids penetrate deep into the body and end up near a major source of blood supply like the heart, the bulbus arteriosus, liver or kidney. Some of them like *Haemobaphes*, *Ophiolernaea*, *Peroderma* and *Lernaeocera branchialis* are known to cause serious damage.

Most of the authentic work has been done on parasites of fresh water fishes. The most elaborately studied parasites are *Ergasilus seiboldi* and *Argulus foliaceous*. In confined waters these parasites have been known to cause mass mortality of fish. In the open sea conditions are very different. Very little is known regarding the activity of the parasites of marine fishes. It is quite possible that under natural conditions well evolved parasites cause only negligible damage. Here both the parasite and the host are subjected to natural laws and the host-parasite relationship might have reached a stable condition. At any rate catches of fish from the open sea only very rarely contain a diseased or disabled fish.

It is quite possible that the diseased ones are unable to keep pace with healthy ones or that they are quickly consumed by the carnivores which are perpetually on the hunt. The sea is no sanctuary for the ill or diseased.

There is general agreement that the parasite has some deleterious effect on the host. Parasitic infections produce loss of weight accompanied by a fall in the fat content of the fish. As the loss of weight mostly occurs in the muscles this reduces the total availability of fish proteins. The activity of the parasite facilitates secondary infection. Organisms like bacteria and fungi normally unable to get a foot-hold may successfully invade the fish in the presence of the crustacean parasite. On the whole it may be safe to conclude that in the marine habitat the copepod parasites do not cause much damage to the hosts.

## ECOLOGY

As observed by Kabata (1970a) nothing is known about the ecology of crustacean parasites. "Most text books on parasitology devote a few scanty paragraphs to crustacea, illustrated with drawings made respectable by their antiquity" This is unfortunate because in variety of organisation and form no other group of aquatic animals can stand comparison with copepods. They are so numerous and have such wonderful plasticity that every available niche is invaded and successfully occupied. There is no group of animals except protozoa which does not have its copepod associates. Yet very little is known of their ecology.

Cressey and Collette (1970) studied the ecology of needle fishes and their parasites and arrived at certain general conclusions which are applicable to other groups of fishes and their parasites. They found that cyclopoid copepods of needle fishes showed little host-specificity and infested whatever kind of needle fish was available. Other copepods were specific in that they were restricted to certain groups of fishes. Thus *Ablennes* and *Tylosurus* are world wide in distribution and occupy the same ecological niche. But they have very distinct parasites. *Caligodes* is not host-specific but shows a preference to oceanic fishes.

The distribution of copepod parasites corresponds with that of the hosts. Till recently *Parapetalus occidentalis* and *Abasia* were known only from the American waters. I collected both from India. It is definite that the distribution of these must coincide with that of their hosts namely *Rachycentron canadus* and lizzard fishes. Cressey (personal communication) who is currently studying the parasites of lizzard fishes has been able to collect many of the species I collected from India. Cressey (1967b) has shown that most of the known species of elasmobranch parasites occur in Indian waters. They have indeed circumtropical distribution coinciding with that of their hosts.

Generally the size of the parasites varies directly proportional to that of the hosts. Cressey and Collette have observed this in the case of *Caligodes*. My own study has shown that this is true of quite a large number of species, for example *Pseudocycnus appendiculatus* and *Caligus robustus*. According to Cressey and Collette older hosts generally have a larger parasitic fauna as they have been exposed to infection for a longer period. They also found that generalised copepods, those capable of freely moving about, infest smaller fishes while specialised ones are confined to larger hosts. In Indian waters *Synestius caliginus* is exclusively parasitic on *Parastromateus niger*. They are very abundant in the buccal cavity of juveniles but rare or absent in older ones. Perhaps this is because older individuals invariably have a large cymothoid almost filling the buccal cavity.

As mentioned before Baer compared the hosts to an island and the parasites to the insular fauna. Animals unable to leave the island tend to form subspecies due to genetic stabilisation of the population. Hence study of the insular fauna throws light on the period of invasion of the island. Parasites evolve more slowly than the hosts and information about the parasites will help in understanding the evolution of the hosts. Hosts harbouring closely related parasites will themselves be closely related. *Gloiopotes* spp. are exclusively parasitic on sail fishes. But *G. hygomianus* is a parasite of *Acanthocybium solandri*. Significantly the latter has been found to be more closely related to sail fishes than hitherto suspected (Cressey, 1967c). A very significant instance was recorded by Kabata (1970c). He found *Brachiella lageniformis* till

then known only from the Atlantic coast of Argentina on *Merluccius* on the east coast of Vancouver island. This discovery enabled him to trace the evolution and distribution of the species of the host fish *Merluccius*. Kabata observed that "in addition to being used as aid in stock discrimination studies, parasitological tags can serve as indicators of phylogenic or zoogeographical relationships"

While studying lernaeopodids from Canadian waters Kabata (1970d) observed considerable morphological variation in *Brachiella robusta*. Analysis of the data revealed that the host *Sebastodes* is in the process of active speciation and the pressure of speciation apparently produced gradual differentiation in the morphology of the parasite. This might result in the evolution of several new species of parasites.

Cressey and Collette examined the question of interspecific competition among copepod parasites. They found that in the case of multiple infection different species occupied different niches on the host or the site of infection varies. They also found definite evidence of competition resulting in one or other species being replaced by a more dominant one. For example all known species of *Pandarus* are found on the body surface of sharks. But Cressey (1968) found that they commonly occurred in the mouth or gill arches on *Isurus oxyrhynchus*. He further observed that in every such case *Dinemoura* was found at the site usually occupied by *Pandarus*. In one instance when *Pandarus* was found at the usual site *Dinemoura* was absent. This habitat shift is an obvious example of interspecific competition.

Several instances of dominance of one species over another were observed during the course of my studies. *Coryphaena* has three species of *Caligus*, *C. coryphaenae*, *C. productus* and *C. quadratus* parasitic on it. But *C. quadratus* is always dominant. *Priacanthus hamrur* has two caligid parasites, *Caligus priacanthi* and *C. hamruri*. The former always dominates. The same is true of two chondracanthid parasites of *Psettodes erumei* ; *Protochondracanthus alatus* is more abundant than *P. trilobatus*.

Studies on copepod parasites have hitherto been mainly taxonomic. The above discussion on ecological aspects will,

I hope, stimulate studies on their biology which is an interesting field of investigation.

## ONTOGENY

The development of several groups of copepod parasites is still unknown. Wilson has traced the developments in several families but most of them are incomplete. Recently a few detailed studies have been published. Those on Caligidae by Lewis (1963), Lernaeoceridae by Ho (1966b) and Lernaeopodidae by Kabata and Cousens (1973) are summarised below.

### **Lepeophtheirus dissimulatus** Wilson

The newly hatched nauplius is obovoid, with rounded anterior and angular posterior ends. The eyes, three pairs of naupliar appendages and balancers are present. After about six hours the first nauplius metamorphoses into the second nauplius.

The second nauplius is similar to the first in the shape of the body but slightly longer. The appendages carry more setae and in the advanced stage body segmentation is evident.

The next moult which occurs in about fourteen hours brings forth the copepodid which is quite different from the nauplius. The body is distinctly segmented and the head is fused with the first thoracic segment. First free thoracic segment carries the second pair of legs and the second free segment a pair of spines. The genito-abdominal segment carries the caudal rami. The third free segment is naked. The frontal organ is visible. The copepodid has all the appendages of the adult except the third and fourth legs.

The copepodid as soon as it contacts a suitable host jabs the body surface with its front and attaches the frontal filament. It then backs off making the filament elongate. By stroking with the maxillae the filament is made smooth.

The first attached larva is the first chalimus. It has an oval dorso-ventrally flattened body. Segmentation of the body remains unchanged but the third leg is present. The fourth legs also make their appearance. This stage lasts for forty hours.

The second chalimus differs from the first in that the second thoracic segment is also fused with the cephalothorax. In the advanced stage the third segment is also taken in. Indications of the frontal plates are also evident. This stage lasts for forty two hours.

The third chalimus is broader than the second. The cephalothorax includes three trunk segments. The genital segment is distinct from the abdomen. Frontal plates are distinct and the vestigial legs appear on the genital segment. Its duration is thirty three hours.

In the fourth chalimus the frontal plates are almost as in the adult. The postero-lateral lobes, posterior sinuses and the H-shaped rib of the cephalothorax are as in the adult. Duration thirty six hours.

The fifth chalimus is seen both attached and free-living. The main difference from the fourth is that its cuticle is thick and the body and appendages consequently more rigid. The cephalothorax acquires a membranous flange. The male chalimus differs from the female in its larger genital segment and the presence of the sixth legs. It lasts for twenty four hours.

The sixth chalimus is the last larva. It may be attached or free. In the female the median lobe of the cephalothorax overlaps the fourth segment. The genital segment is broader than long. In the male the fourth segment is fully exposed and the genital segment is longer than broad. Duration of this stage is twenty four to thirty hours.

After the moult into the adult the appendages remain unchanged. The male does not grow further and copulation takes place immediately. The genital segment of the female enlarges making it outgrow the male in size. The male clasps the fourth segment or the genital segment of the female with its antennae modified for this purpose and bending its body implants a pair of spermatophores. The maxillipeds take no part in this.

With regard to the number of chalimi involved in individual development of caligids there is some difference. Kabata (1972a)

concluded that all caligids so far studied have a development comprising of five phases and ten stages. namely, two naupliar, one copepodid, four chalimus, two preadult and one adult stages.

**Cardiodectes** sp.

The egg hatches out into a copepodid with an elongated anteriorly rounded, posteriorly truncate, parallel-sided cephalothorax followed by four free segments (second to fourth pedigerous segments and the genito-abdominal segment carrying the caudal rami). Caphalothorax includes only the first thoracic segment. The first two pairs of legs are well developed but the third is represented only by a pair of spines. The antennule is four-jointed and the antenna three-jointed and subchelate. Eyes are well developed.

On contacting the appropriate host (*Ianthina*) the copepodid drives its antennae into the host and creates two holes into which the secretion of the frontal gland flows. The attachment organ thus formed consists of a conical base bifurcating and enlarging into two globular structures which remain embedded in the tissue of the host.

Soon after attachment the copepodid moults and the chalimus attaches itself with the help of new secretion from the frontal gland to the base of the attachment organ already formed by the copepodid. Since a part of the discarded exuvium will remain attached to the frontal organ the number of these remnants gives a clue to the number of moults that have occurred.

The first chalimus shows much retrogressive metamorphosis. The cephalothorax is narrow at both ends. The antennule is unsegmented and devoid of setae. Antenna is not chelate. The appendages have spine-like non-plumose setae. The segmentation of the post-cephalothoracic part is indistinct. The fourth free segment gets differentiated into genital and abdominal segments.

In the second chalimus sexual dimorphism is evident. The female is elongated and the male elliptical. Antennules, maxillipeds, fourth legs and caudal rami also exhibit dimorphism. The genital

segment of the female is longer than that of the male. The antennules are still unsegmented but the antennae regain their chela.

The third female chalimus has a more elongated body mainly because of the elongation of the genital segment. In the male the spermatophores are visible within the body and the maxillipeds project laterally. The appendages more or less take on the adult structure but the fourth legs are yet to develop.

The free swimming adult male has a squarish cephalothorax with large rostrum and truncate hind end. There are five free segments, first two with a pair of legs, third limbless and fourth fused with the genito-abdominal segment which is swollen with spermatophores. Antennules are clearly four jointed. Antennae are strong and subchelate. Maxilliped is two-jointed.

The free swimming adult female is slender and longer, with an oblong cephalothorax, rounded in front and truncate behind. Rostrum is conical. First three thoracic segments carry legs and the genital segment is long and rugose.

Pairing takes place with a female in any stage of maturity. The male holds the female with its antennae and maxillipeds, the former holding the rostrum and the latter the lateral edges of the cephalothorax. When the female leaves the intermediate host it carries the spermatophores. The female soon finds the final host and gets firmly attached. The male dies after pairing.

**Salmincola californiensis** (Dana)

The first free swimming larva is the copepodid. It has a fusiform forebody with indistinct median transverse partition and a hind body demarcated into three segments. The forebody carries the antennules, antennae, mandibles, maxillules, maxillae and the maxillipeds and the frontal filament. The frontal filament consists of three loops having a large proximal plug and a small distal plug. At the hind end of the forebody is the first pair of legs. The first segment of the hind body is broad and carries the second legs and the second segment a pair of vestigial legs. Caudal rami are small. The copepodid must find a suitable host within two days.

On contacting a host the copepodid thrusts its antennae into the host. The maxillae and maxillipeds may also assist in this. The larva then explores the surface of the body of the host for a suitable site for attaching the frontal filament. Having found a skeletal tissue the copepodid firmly holds on to it with the antennae and maxillae. With the help of the maxillipeds it excavates a hole between the points of penetration of the antennae. The front end of the head is then thrust into the excavation and the frontal filament is cemented to the skeleton by using the secretion of the frontal gland. The copepodid now walks backwards till the filament is fully everted.

After getting attached the larva moults. The maxillae move to the base of the frontal filament and attach themselves to it with the help of some cement from the frontal gland. The filament is then detached fron the front end of the body and the copepodid slides forward out of the old cuticle.

The first chalimus lasts for about two hours. It is much different from the copepodid. Its body is not demarcated into forebody and hindbody and the appendages are shorter and heavier, with reduced armature. Maxillae have small subchela with recurved two-pronged bar embedded in the basal plug of the attachment organ. The main event during this stage is the transference of frontal filament to the maxillae.

The process of moulting into the second chalimus is as in the first. But the reattachment of the parasite to the filament is laborious. The maxillae manouvre the filament to the frontal gland and press it firmly into the secretion with the help of the antennae. The chalimus still in the cuticle of the first brings its maxilae to the base of the filament and the new claws detach the filament and move back to their original place with the filament. Even now the exuvium remains attached to the filament and is cut away with the mandibles. The maxillary claws of successive chalimi remain embedded in successive drops of secretion at the base of the filament. The second chalimus generally resembles the first but there is greater fusion of the tagmata and reduction of appendages. The maxillae are longer and more robust. The second chalimus lasts twelve hours.

In the third chalimus sexual dimorphism is evident. The male lasts twenty four hours and the female forty eight hours. The posterior extremity of the male is flexed dorsalwards, hind body is elongated and the maxillae are longer.

The fourth male chalimus shows one important change namely that in forty eight hours it moults and does not get reattached. It contacts the body of the host and clings on with the antennae, maxillae and maxillipeds and wanders in search of a female. The female chalimus enters a crucial phase namely the reversal of the positions of the maxillae and maxillipeds. The maxillipeds grasp the body of the host and step over the linked maxillae one at a time. Using the second antennae the chalimus now moves forward dragging the filament. Due to the continuous growth of the body the distance between the maxillae and the maxillipeds increases. The forward movement of the female makes the filament taunt and it breaks leaving the last drop of secretion and a bridge connecting the two maxillae. The fourth chalimus lasts two weeks.

The freed female chlimus finds a suitable host and excavates a cavity for implanting the bulla with the help of the mandibles, maxillules and maxillipeds. The search is however difficult as the linked maxillae are of no use. The chalimus moults and gets the antennae freed which now act as attachment organs until the maxillipeds get freed.

Immediately after moulting the bulla is everted and inserted into the host. The animal now rotates its maxillae and on contacting the bulla adjusts them so that their ducts open at the base of the manubrium. The maxillary plug is inserted into the manubrium and the contact is made permanent by cement secreted by the maxillary gland. The bulla increases in bulk as more and more secretion flows into it. The female meanwhile increases in size.

Males copulate even with immature females. The thin tubes of the spermatophores enter the vaginal orifices which get sealed off. No more fertilisation is hence possible.

## Order *COPEPODA*

*Diagnosis.*—Body composed of head, thorax and abdomen. Head often fused with one or more thoracic segments forming a

cephalothorax. Thorax typically six-segmented but fusion with head or among them reduces their number. In many the fifth and sixth segments fuse to form a genital segment. In parasitic members like lernaeocerids body without segmentation, but divisible into head and trunk, latter showing a neck and abdomen, the last often lacking.

Head with six pairs of appendages (except in lernaeocerids and *Hatschekia*), antennules, antennae, mandibles, maxillules, maxillae and maxillipeds. Each thoracic segment with a pair of biramous legs, united by an intercoxal plate. Legs typically biramous, with two-jointed protopod and three-jointed rami, but much modified or even absent in parasitic groups. Anal segment of abdomen usually with a pair of caudal rami, not considered as appendages, occasionally reduced to a few setae.

*Discussion.*—Depending on habitats copepods vary considerably in the shape of their body. Hence a classification based on their external morphology may be unnatural and misleading. Of all the attempts so far made the one proposed by Wilson (1932) based mainly on the scheme evolved by G. O. Sars is still useful. Yamaguti (1963) effected some important changes but apart from some factual errors his scheme as pointed out by Stock (1965) is based on external morphology. As expressed by Stock classification of the copepoda will have to be based on the nature of their oral appendages. Until such a classification becomes available I follow Wilson (1932) with the difference that Chondracanthidae and Lernaeidae are included in the Cyclopoida.

*Key to suborders of COPEPODA*

1. Egg sacs slender, eggs uniseriate, body varying in shape and segmentation, free moving or permanently fixed, male not much modified ... ... ... ... *CALIGOIDA*
— Egg sacs stout, eggs multiseriate, body with or without segmentation, male slightly or highly modified ... ... ... ... ... ...2
2. Body segmented (except in highly modified members), legs present, eggs rounded and loosely packed, male only slightly modified (except in highly modified members), oral appendages bitting type ... ... ... ... *CYCLOPOIDA*

— Body unsegmented, legs absent, eggs polygonal, closely packed, male highly modified, oral appendages piercing and sucking type ...*LERNAEOPODOIDA*

## Suborder *CYCLOPOIDA*

*Diagnosis.*—Body segmentation distinct or much reduced. Both sexes capable of freely moving about or sedentary. Egg sacs cylindrical, subdorsal, never ventral, eggs multiseriate. Antenna prehensile or not. Mouth parts biting type, not adapted for piercing or sucking. Mandible and maxilla ending in serrate blades. Maxillule associated with paragnath. Maxilliped usually present, not prehensile. Legs normal or reduced.

Male normally developed and free moving or a degenerated dwarf permanently attached to the female.

Free swimming, commensalic or parasitic.

*Discussion.*—With the inclusion of Chondracanthidae the definition of the suborder given by Yamaguti has to be modified. It is now generally conceded that Lernaeidae and Therodamasidae should be placed under Cyclopoida. *Lamproglena* and allied genera now included in Dichelesthiidae should also come under Cyclopoida (Sproston et al 1950). The suborder is apparently heterogeneous but the nature of the mouth parts and the shape of the egg sacs reveal unmistakable affinity.

### *Key to families of CYCLOPOIDA*

1. Body segmentation largely obscured, thoracic limbs usually reduced to simple lobes, antenna strongly prehensile, male a dwarf attached to female ... ... ...CHONDRACANTHIDAE

— Body segmentation distinct, thoracic limbs normally developed or slightly reduced, antenna not prehensile, male free living ... ... ... ...2

2. Maxillipeds lateral to other mouth parts ...BOMOLOCHIDAE

— Maxillipeds posterior to other mouth parts ... ...TAENIACANTHIDAE

## Family BOMOLOCHIDAE

*Diagnosis.*—Body dorso-ventrally flattened, varying in shape. Cephalon fused with first thoracic segment, forming a cephalothorax, rest of body varying in shape. In Tuccinae second thoracic segment forming a long neck, but successively narrowing in Bomolochinae. Abdomen short, one-segmented in Tuccinae,three-segmented in Bomolochinae. Genital segment formed by the fusion of two segments, post-genital segments one to three in number. Caudal rami cylindrical, with up to six setae.

Antennule demarcated into peduncle and flagellum, former indistinctly segmented, with plumose setae, latter clearly segmented, with naked setae. Antenna three-jointed, armed with hooks and spines, Mandible ending in two apical blades. Maxillule with two to four setae, paragnath present. Maxilla ending in two barbed blades and a spine. Maxilliped three-jointed, third segment a claw curved over the second segment. First leg highly flattened, with indistinctly three-jointed rami, legs two to four with one-to three-jointed rami. Fifth leg uniramous and two-jointed. Sixth leg represented by three setae on the genital segment.

Male smaller than female. Genital segment large, abdomen two-jointed. Antennule not flattened, with naked setae. Maxilliped very large and subchelate. Legs with reduced armature and segmentation. Fifth leg with two setae on distal segment.

Type genus : **Bomolochus** Nordmann

*Discussion.*—The above diagnosis is mainly based on that given by Vervoort (1962) but antenna is described as three-segmented and the exopods of legs two to four as three-segmented. Under the term abdomen Vervoort included the fifth segment, genital segment and the post-genital somites. But in the present work the terms fifth segment, genital segment and abdomen are used without reference to their true homology.

Originally Bomolochidae included *Taeniacanthus* and allied genera also. But Vervoort (1962) created Taeniacanthidae to accommodate them. Vervoort divided Bomolochidae into

Bomolochinae Claus and Tuccinae Vervoort. Tuccinae differs from Bomolochinae in the elongation of the second thoracic segment. As this subfamily is not represented in the Indian fauna it will receive no more attention here.

## Subfamily BOMOLOCHINAE

*Diagnosis.*—Rostral plate of cephalothorax bent downwards. Maxillipeds lateral to other mount parts. First leg flattened, with one-to three-segmented rami. Legs two to four with three-segmented rami (sometimes reduced). Leg five two-segmented. Abdomen three-segmented.

Male with armature of antennule and legs different. Maxilliped large and prehensile.

*Discussion.*—Bomolochinae includes *Bomolochus* Nordmann, (1832), *Holobomolochus* Vervoort (1969), *Dicrobomolochus* Vervoort (1969), *Nothobomolochus* Vervoort (1962), *Orbitacolax* Shen (1957a), *Pseudorbitacolax* Pillai (1971), *Pumiliopes* Shen (1957a), *Pumiliopsis* Pillai (1967a) *Acanthocolax* Vervoort (1969), *Ceratocolax* Vervoort (1965) and *Pseudoeucanthus* Brian (1906). Only seven of these occur in Indian waters.

*Key to the genera of* BOMOLOCHINAE

1. Thoracic limbs two to four with three-jointed rami ... ... ... ... ... ... ...2
— Thoracic limbs two to four with two-jointed rami ... ... ... ... ... ... ... ...5
2. Limbs with reduced armature, surface of segments conspicuously spiny ... ... ... ... ...3
— Limbs with normal armature, surface of segments, when spiny, only moderately so ... ... 4
3. Cephalothorax much broader than thoracic segments ... ... ... .**Pseudorbitacolax** Pillai
— Cephalothorax not much broader than thoracic segments ... ... ... .**Orbitacolax** Shen
4. Antennule with setae three to five modified into strong spiness ... ... .**Nothobomolochus** Vervoort
— Antennule with seta four modified into a spine ... ... ... ... **Bomolochus** Nordmann
— Antennule with all setae normal (fourth may be slightly modified) ... **Holobomolochus** Vervoort

5. Setae on maxillule subequal in length, apical claw of exopod of legs two to four naked ..... **Pumiliopes** Shen

— One of the setae on maxillule very long, apical claw on exopod of legs two to four with spines or teeth ..... **Pumiliopsis** Pillai

## Genus **Bomolochus** Nordmann

*Bomolochus* Nordmann, 1832, p. 135; Wilson, 1932, p. 381; Vervoort, 1962, p. 9; 1969, p. 2.
*Parabomolochus* Vervoort, 1962, p. 31.

*Diagnosis.*—Cephalothorax semicircular and vaulted, thoracic segments successively narrowing. Rostral plate bent downwards, apically bifid. Abdomen three-jointed. Caudal rami cylindrical and narrowing, with five setae, apical two setae long. Antennule with peduncle flattened, indistinctly three-jointed, prolongations of chitinous plates fuse with setae three to thirteen, seta four converted into a strong hook. First naked seta small. Antenna with longitudinal rows of spines or tubercles on third segment and a row of comb-like spines continued on to the lamellar process. Maxillule with four setae. Claw of maxilliped strongly curved, with accessory process. Rami of first leg highly flattened, exopod segments often fused. Rami of legs two to four three-jointed, endopod of leg two broad, endopod of fourth leg with reduced armature, spines on exopods of legs two to four flagellated.

Male much smaller than female. Genital segment large, formed of three segments. Abdomen two-segmented. Antennule with naked setae. Maxilliped large and subchelate. First leg only moderately flattened. Endopod of leg four two-jointed. Second segment of leg five with two setae.

Type-species : *B. soleae* Claus

*Discussion.*—A heterogeneous assemblage of species was assigned to *Bomolochus*. Vervoort (1962) divided the genus into *Bomolochus*, *Parabomolochus*, *Bomolochoides* and *Nothobomolochus*, primarily based on the structure of the antennule.

While studying *B. soleae* Claus, Vervoort (1969) discovered that the fourth seta on its antennule is modified into a hook which

is the one character that distinguishes *Parabomolochus* from *Bomolochus*. The consequence of this discovery was that all species with the fourth antennular seta modified had to be transferred to *Bomolochus*. This also necessitated the creation of a new genus, *Holobomolochus* Vervoort (1969) for accommodating those species which were previously placed under *Bomolochus*. *Parabomolochus* Vervoort (1962) thus became a synonym of *Bomolochus*.

Re-examination of *Bomolochus nitidus* Wilson (1911a) and *B. scutigerulus* Wilson (1935a) showed that the former is a true *Bomolochus* and the latter a *Holobomolochus*. Hence *Bomolochoides* Vervoort (1962) which was created to contain these two species had to be withdrawn. Reexamination of *Bomolochus eminens* Wilson showed that it could belong to no known genus. Hence Vervoort (1969) created *Dicrobomolochus*. This genus is characterised by the modification of the second and third setae on the antennule into spines.

Genus *Bomolochus* now contains *B. soleae* Claus (1864), *B. megaceros* Heller (1868a), *B. unicirrus* Brian (1902), *B. concinnus* Wilson (1911a), *B. exilipes* Wilson (1911a), *B. cuneatus* Fraser (1920), *B. decapteri* Yamaguti (1936a), *B. tumidus* Shiino (1957d), *B. hyporhamphi* Yamaguti and Yamasu (1959), *B. psettobius* Vervoort (1962), *B. mycterobius* (Vervoort, 1965), *B. anonymous* (Vervoort, 1965), *B. hemirhamphi* Pillai (1965), *B. selaroides* Pallai (1965), *B. monoceros* Pillai (1965), *B. bellones* Burmeister (1835), *B. ensiculus* (Cressey and Collette, (1970), B. *constrictus* (Cressey and Collette, 1970), and *B. sinensis* (Cressey and Collette, 1970). Only six species have so far been recorded from Indian waters.

*B. unicirrus* Brian was recorded by Thomson and Scott (1903) from Sri Lanka and *B. parvulus* Nordmann (1932) from the Red Sea. As both records are doubtful these are omitted from the present study.

*Key to species of* **Bomolochus**

1. Spine on base of antennule longer than adjacent setae ... ... ... ... ... ...2
— Spine on base of antennule not longer than adjacent setae ... ... ... ... ... ...4

2. Spines two to five on exopod of leg two with different armature ... ... ... *.megaceros* Heller
— Spines two to five on exopod of leg two with same armature ... ... ... ... ... ...3
3. Exopod segments of legs externally pustulose ... ... ... ... *.monoceros* Pillai
— Exopod segments of legs externally not pustulose ... ... *.selaroides* Pillai
4. Setae following the antennular spine modified and spine-like *.multiceros* Pillai and Natarajan
— Setae following the antennular spine not modified ... ... ... ... .5
5. Distal segment of leg five short, irregular in shape, inner spine weak ... ... ...*bellones* Burmeister
— Distal segment of leg five long, regular in shape, inner spine strong ... ... ...*hemirhamphi* Pillai

## **Bomolochus bellones** Burmeister
(Fig. 1)

*Bomolochus bellones* Burmeister, 1835, p. 298, pl. 24, figs. 1-6; Leigh-Sharpe, 1935, p. 268, fig. 3; Yamaguti 1963, p. 398; Pillai and Natarajan, 1977, p. 22, figs. 11-20.

*Parabomolochus bellones* Vervoort, 1962, p. 34, figs, 1-4; Cressey and Collette, 1970, p. 365, figs. 71-72.

*Female.*—Cephalothorax broad and laterally rounded, broadest in the middle, hind border nearly straight. Second thoracic segment laterally rounded and postero-medially concave. Third thoracic segment fairly large, transversely oblong, fourth somewhat squarish, overlapped by third and overlapping fifth, latter short, as broad as fourth. Genital segment squarish, as broad as fifth segment. Abdomen fairly stout, progressively narrowing. Caudal rami twice as long as broad, slightly narrowing, inner apical seta twice as long as outer. Egg sacs long and stout.

Basal segments of antennule almost fully fused, claw stout and strongly curved, hardly projecting beyond the adjacent setae. First naked seta very small, second very long, third of medium length. Distal segment of antenna with longitudinal rows of denticles and a ventral row of long blunt spines, there are in all seven claws. Mandible with large apical and small subapical blades. Maxillule with four setae, one stout. Paragnath smooth and narrowing. Maxilla with two barbed subequal blades and a spine. Claw of maxilliped very stout, with small curved accessory process.

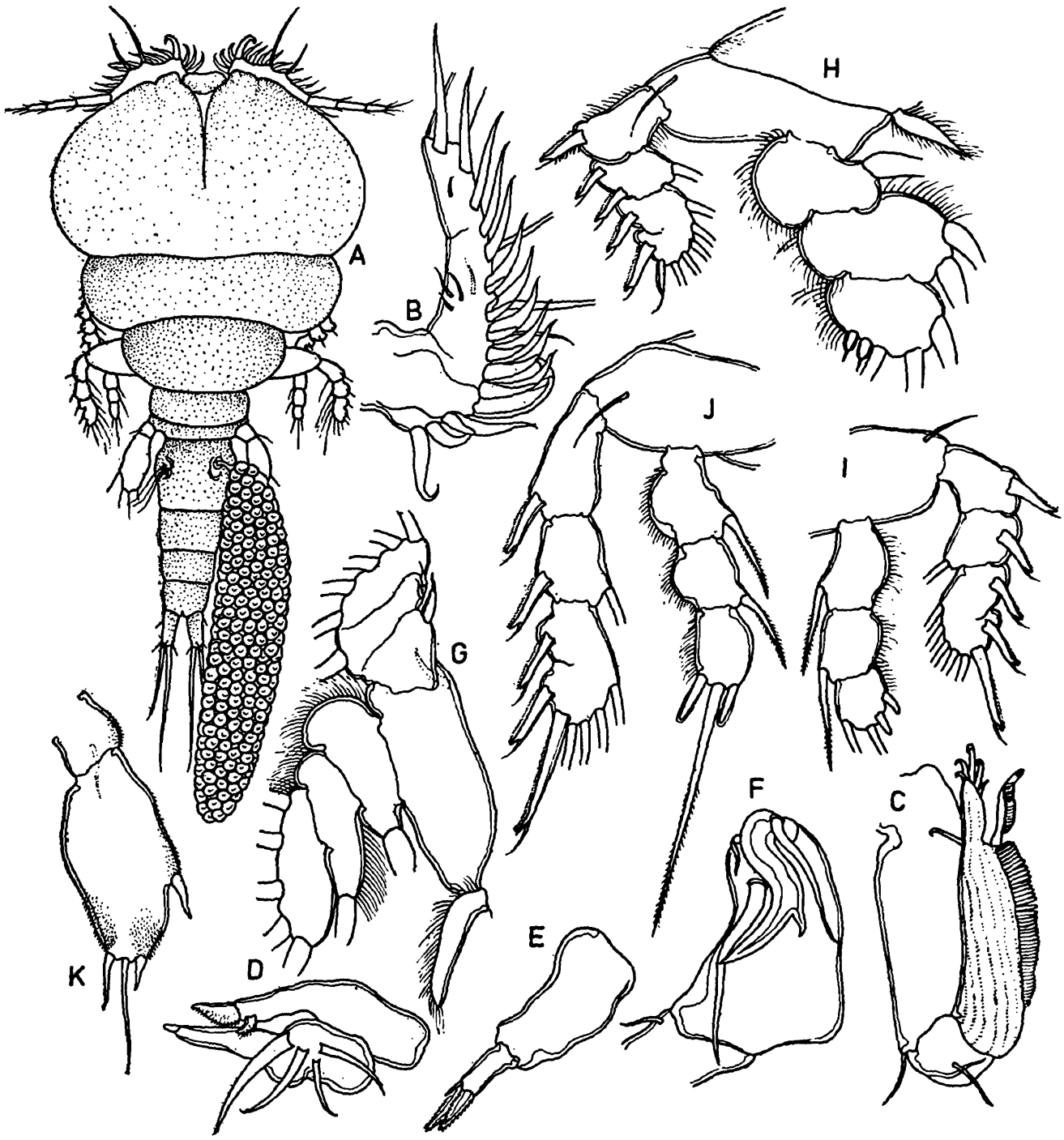


Fig. 1. A-K. *Bomolochus bellones* Burmeister : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible and maxillule ; E, maxilla , F, maxilliped ; G-K, legs 1-5.

Rami of first leg highly flattened and three-jointed. Endopod of second leg as broad as that of first, first claw of exopod spiny on both sides, second to fifth dorsally spiny, both borders of first exopod segment hairy. Third leg comparatively small, all the

claws on exopod externally spiny, setae on inner border of endopod spiniform and pectinate. Fourth leg longer than third, its exopod clearly longer than endopod, apical spine of both rami very long, distal lateral spines of third endopod segment blunt and winged. Basal segment of fifth leg small, distal irregularly elliptic, outer spines short but shout, inner setiform, distal seta long.

*Length.*—1.8 mm

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 1+II, 5 |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Ablennes hians, Belone belone, B. svetovidovi, Platybelone argalus, Strongylura anastomella, S. leiura, S. incisa, S. marina, S. timuca, S. urvillii, Tylosurus acus, T crocodilus, Lhotskia gavialoides.*

*Distribution.*—Indian Ocean, Pacific ocean, Atlantic ocean, Mediterranean and Red Sea.

*Remarks.*—Vervoort has described this species in detail and recently Cressey and Collette recorded it from the tropical waters of all the seas. My specimens from *Belone belone* and *Ablennes hians* show a very characteristic irregularity in the fifth leg. There are other minor differences also. Cressey and Collette found that the variations are clearly geographic.

## **Bomolochus hemirhamphi** Pillai
(Fig. 2)

*Bomolochus hemirhamphi* Pillai, 1965, p. 49, fig. 20.
*Parabomolochus hemirhamphi* Pillai, 1967d, p. 1565, fig. 15.

*Female.*—Cephalothorax semicircular, postero-laterally produced and embracing the second thoracic segment, hind border evenly concave. Second thoracic segment only slightly narrower than

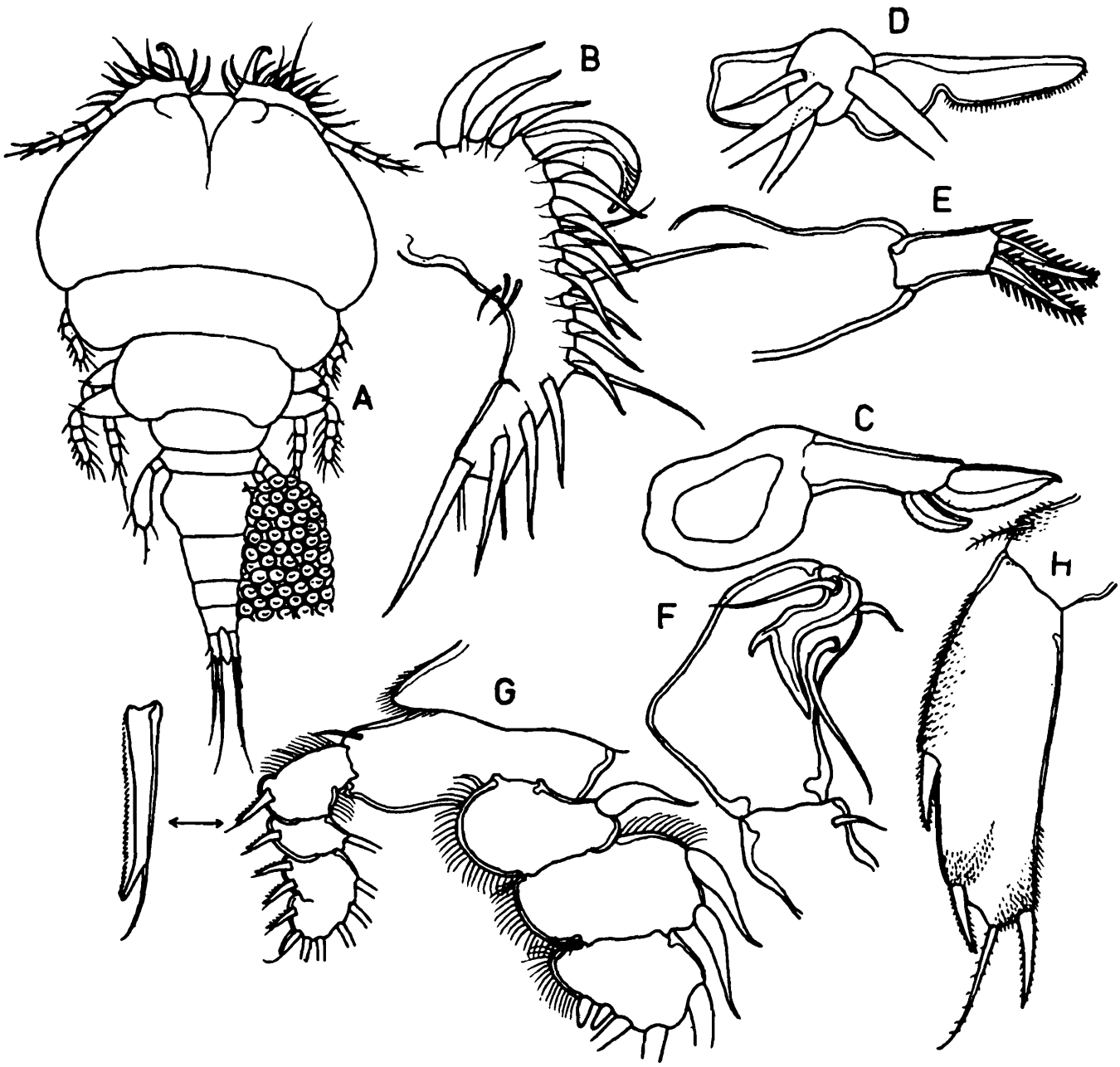


Fig. 2. A-H. *Bomolochus hemirhamphi* Pillai : A, female, dorsal view ; B, antennule ; C, mandible ; D, maxillule ; E, maxilla ; F, maxilliped ; G, leg 2 , H, leg 5.

cephalothorax, laterally overlapping third, latter longer than second and considerably overlapping fourth. Fifth segment short, overlapped by fourth. Genital segment large, broader than long, as broad as fifth segment. Abdomen sharply narrowing. Inner distal seta of caudal rami one and a half times as long as outer distal. Cephalothorax together with thoracic segments two to four describing a near circle. Egg sacs stout and oblong.

Spine-like process on antennule strongly curved and stout, its distal part grooved, naked setae as in *B. bellones*. Distal segment of antenna with longitudinal rows of tubercles, ventral border with a long row of blunt comb-like spines, lamellar process and linguiform extension small, claws short, six in number. Mandible with broad apically sharp and curved distal blade. Maxillule with three stout and one slender setae. Paragnath long, upper border straight, lower spiny and with a deep incision. Claw of maxilliped small, strongly curved, accessory process apically hook-like.

Rami of first leg only moderately flattened, three-segmented. Endopod of second leg very broad, both borders of first exopod segment hairy, claws one to five on exopod with pectinate external wing. Rami of third leg narrow, endopod smaller, spines on exopod progressively becoming longer. Endopod of fourth leg slender, spines on distal segment winged. Distal segment of fifth leg narrow at both ends, apical seta long, spines large and subsimilar.

*Length.*—1.8 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+II |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 2+II | 0+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Hemirhamphus far.*

*Distribution.*—India (Kerala).

*Holotype*-female in the National Zoological Collections at Zoological Survey of India, Calcutta. Reg. No. C 4614/1.

## **Bomolochus megaceros** Heller
(Fig. 3)

*Bomolochus megaceros* Heller, 1868, p. 153; pl. 13, fig. 2; Bassett-Smith, 1898*a* p. 2 ; 1898*c*, p. 358, pl. 10, fig. 1 ; Gnanamuthu, 1949, p. 359, figs. 1-7 ; Kirtisinghe, 1964, p. 48, fig. 6; Pillai, 1965, p. 43, fig. 17.

*Bomolochus* (*Pseudobomolochus*) *decapteri* Shen, 1957*a*, p. 305, pls. 5-6.

*Parabomolochus megaceros* Vervoort, 1962, p. 43; Pillai, 1967*d*, p. 1565, fig. 13

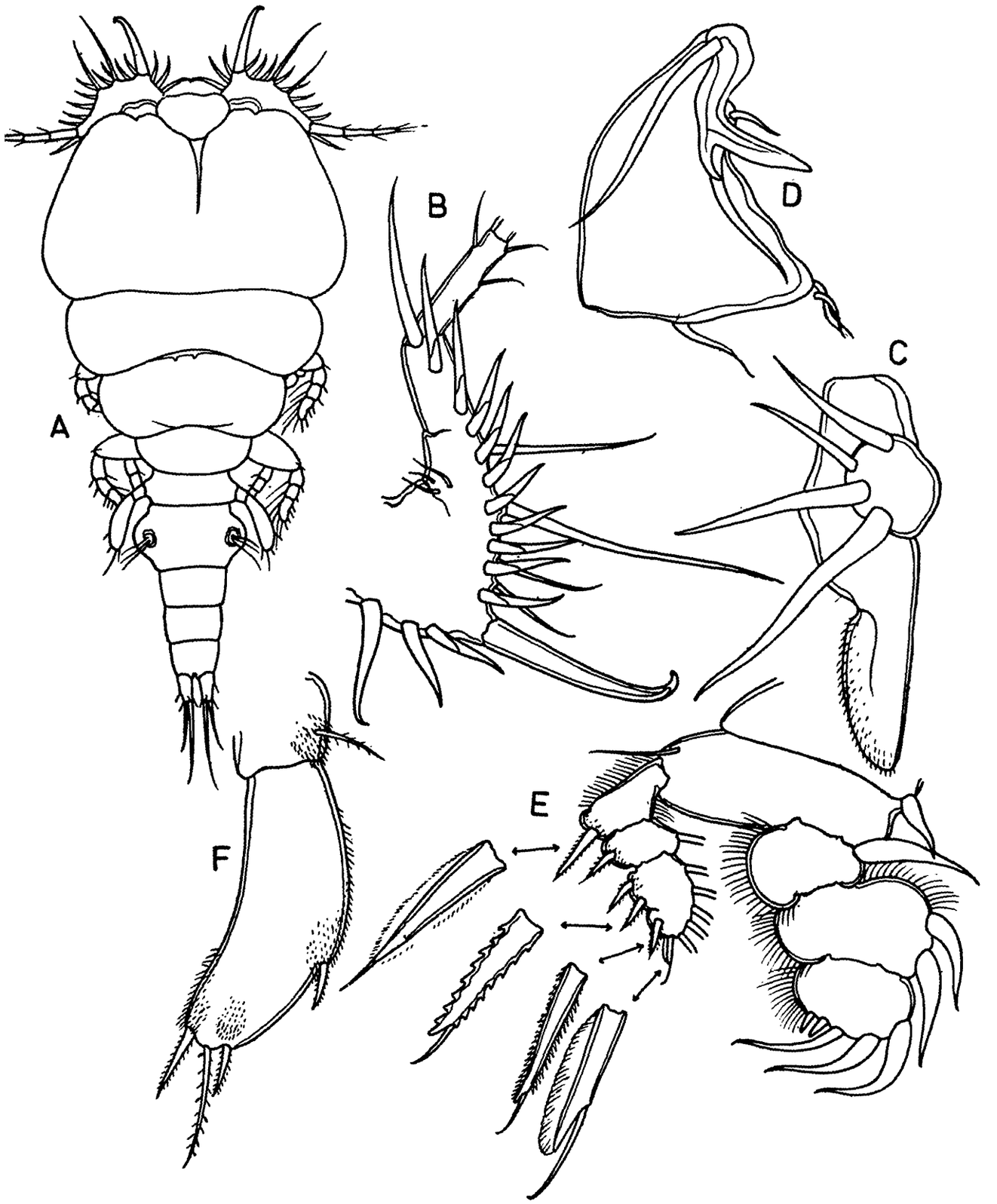


Fig. 3. A-F. *Bomolochus megaceros* Heller : A, female, dorsal view ; B, antennule ; C, maxillule ; D, maxilliped ; E, leg 2 ; F, leg 5.

*Female.*—Cephalothorax nearly rectangular, with well rounded corners, hind border nearly straight, rostrum prominent and projecting. Second thoracic segment narrower than cephalothorax, third postero-medially deeply concave, laterally overlapping fourth, distal border of latter evenly rounded. Fifth segment short, much broader than long, but narrower than fourth segment. Genital segment medially bulging, broader than fifth segment. Abdomen short, gradually narrowing. Caudal rami strongly narrowing, distal inner seta about twice as long as outer. Egg sacs about half as long as body.

Antennular peduncle prominently projecting, claw long, straight and apically curved. Third segment of antenna with longitudinal rows of tubercles, lamellar process with a row of longer spines and a spiny crest near its base, four claws and two setae also present. Distal blades of mandible subequal, curved dorsalwards. Maxillule with two stout and two small setae, paragnath with straight upper border and spiny lower border with a median incision. Second segment of maxilliped comparatively broad, claw strongly curved, accessory process prominent.

Rami of first leg moderately flattened, exopod two-jointed. Endopod of second leg highly flattened, exopod comparatively small, claws with four types of armature, outer part of segments pustulose, spines on third endopod segment winged and distally drawn out. Exopod segments of third leg more prominently pustulose, apical spines of endopod winged, with apical spinule. Rami of fourth leg elongated, endopod particularly so, spines on third endopod segment winged. Distal segment of fifth leg elongate oblong and curved, spines succesively increasing in length, seta pectinate.

*Length.*—2.9 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 3+I, 3+II |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 2+II | 0+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Male.*—Cephalothorax broadest in the middle, rostrum large, thoracic segments two to four strongly narrowing, second equal to fourth in length, fifth segment broadening distalwards, partially fused with genital segment. Genital segment swollen, broader behind. Abdomen slender, three-jointed, first segment fused with genital segment.

Second segment of maxilliped comparatively slender, with two setae, third with a basal partition carrying two setae. Distal segment of fifth leg with two patches of spinules and two spines.

*Length.*—1.3 mm.

*Host.—Parastromateus niger, Caranx djedaba, Stromatoides sinensis, Caranx* sp., *Mugil* sp., *Therapon theraps, Megalaspis cordyla.*

*Distribution.*—Indian Ocean, (Bombay, Madras, Kerala), China, Baluchistan.

*Remarks.*—The original description of this species by Heller and redescription by Gnanamuthu are unsatisfactory. As pointed out by Vervoort, Gnanamuthu described an young female as male. This large and abundant species can be easily recognised by the long slender, nearly straight processes on the antennule.

**Bomolochus monoceros** Pillai
(Fig. 4)

*Bomolochus monoceros* Pillai, 1965, p. 53, fig. 22.
*Parabomolochus monoceros* Pillai, 1967*d*, p. 1567, fig. 16.

*Female.*—Cephalothorax comparatively large, as long as the combined length of the next three thoracic segments, broadest behind. Hind border nearly straight. Rostral plate not projecting. Second thoracic segment with slanting sides, as long as third segment, latter with rounded distal border, overlapping fourth. Fourth segment hiding nearly half of fifth segment. Genital segment broader than long, as broad as fifth segment. Abdomen short, narrowing, anal segment particularly so. Caudal rami

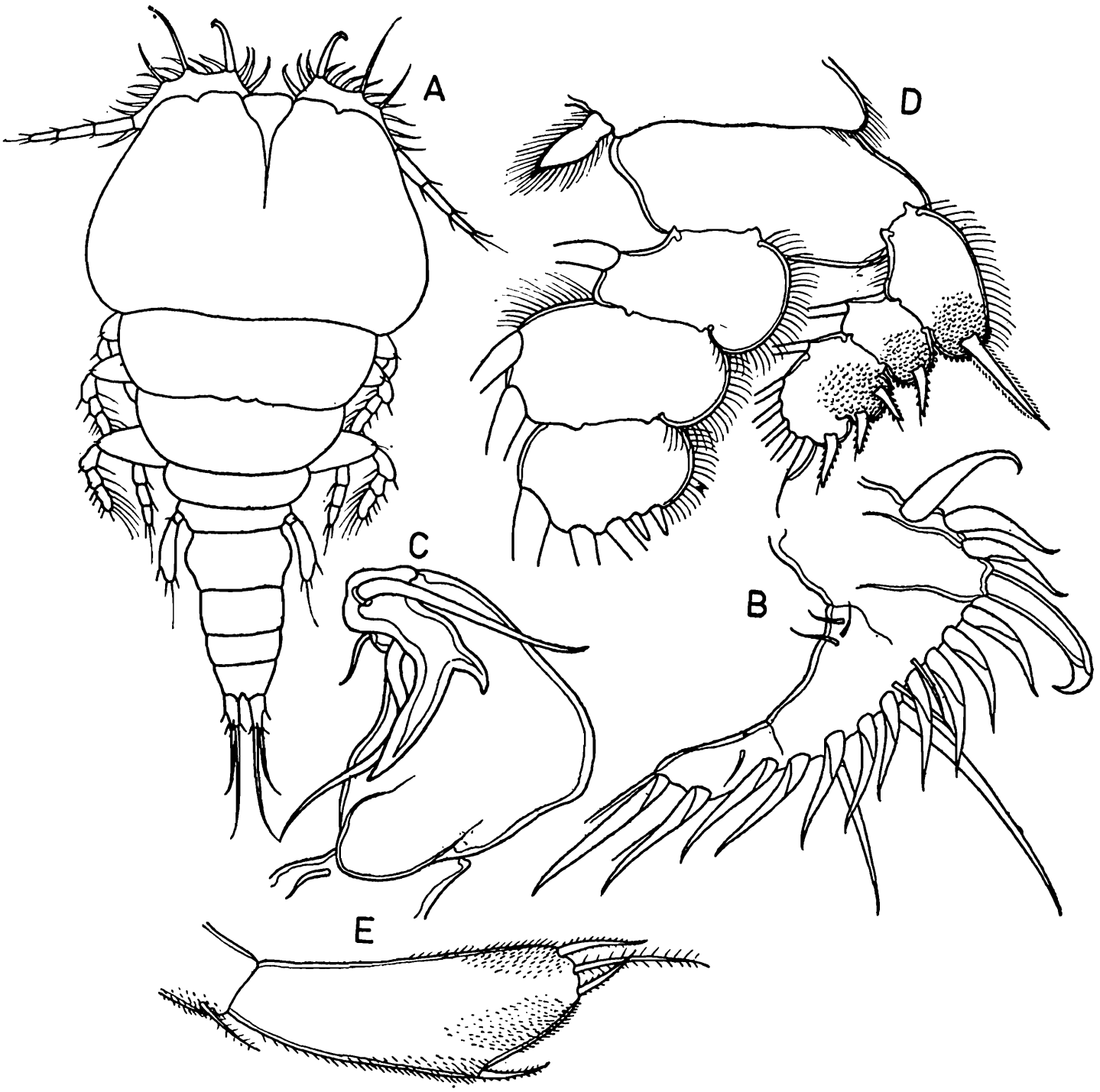


Fig. 4. A-E. *Bomolochus monoceros* Pillai : A, female, dorsal view ; B, antennule; C, maxilliped ; D, leg 2 ; E, leg 5.

strongly narrowing, apical inner seta nearly twice as long as outer. Egg sacs slender, as long as pregenital part of body.

Peduncle of antennule fairly deep but not much projecting. Spine-like process stout, broad except at the curved tip, apex acute. Third segment of antenna with longitudinal rows of tubercles, ventral row of long spines, spiny lamellar process and seven

hooks. Apical blades of mandible subsimilar. Maxillule with four comparatively small setae. Paragnath as in *B megaceros* but naked. Blades of maxilla unilaterally spiny. Maxilliped with well developed claw, accessory process large.

Rami of first leg three-jointed, only moderately flattened. Exopod of second leg large, segments prominently pustulose, first spine long and winged, others denticulated, endopod broad, spines on third segment winged and apically prolonged. Endopod of third leg slightly broader than exopod. Endopod of fourth leg slender, longer than exopod. Exopod of legs two to four pustulose. Distal segment of fifth leg rather slender, conspicuously spinulose, spines setiform.

*Length.*—1.9 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+II |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Carangoides malabaricus.*

*Distribution*—India (Kerala)

*Holotype*-female in the National Zoological Collections at Zoological Survey of India, Calcutta. Reg. No. C2100/2.

## **Bomolochus multiceros** Pillai and Natarajan
(Fig. 5)

*Bomolochus multiceros* Pillai and Natarajan, 1977, p. 19.

*Female.*—Cephalothorax hemispherical, with irregular outline, frontal plates rather large and projecting. Second thoracic segment transversely rectangular, with rounded sides, narrower than cephalothorax. Third segment much narrower than second, fourth very small, fifth roughly triangular, as broad as fourth segment. Genital segment swollen, as broad as fifth segment. Abdomen

short. Caudal rami comparatively long, narrowing, distal inner seta more than twice as long as outer. Egg sacs slender, as long as pregenital part of body.

Setae three to fourteen on antennule fused with chitinous prolongations, but fourth to sixth alone modified though the succeeding setae only gradually decrease in length giving the antennule a striking appearance. First naked seta very long and stout, placed away from the process. Third segment of antenna with scattered sharp spinules, ventral border with fairly long well spaced spines. Lamellar process with well spaced spines, hooks four, seta one, there is no bulge at the base of the lamellar process.

Distal blade of mandible exceptionally long, slender, naked and curved upwards, subsidiary process very small. Maxillule with four setae, one exceptionally large. Maxilla with one spinule and two slender barbed processes. Second segment of maxilliped comparatively small, claw stout, strongly curved, accessory process long.

First leg only moderately flattened, rami distinctly three-segmented. Endopod of second leg highly flattened, spines on third segment very small, with small apical process, exopod comapratively small, basal segment externally profusely hairy, claws slender and pectinate, first claw comparatively long. Endopod of third leg very slightly broader than exopod, spines on third segment longer than those on second leg, basal segment of exopod externally spiny, claws slender and long. Endopod of fourth leg exceptionally long, basal segment with characteristic inner curvature, inner setae converted into short pectinate spines, third segment slender, with comparatively long pectinate spines. Claws on exopod very long, last claw as long as the nearest seta. Fifth leg slender and conspicuously spinulose, spines weak and pectinate, seta long, selnder and pectinate.

*Length.*—2.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 1+I, 5+I |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+1, 1+I, 6+II |

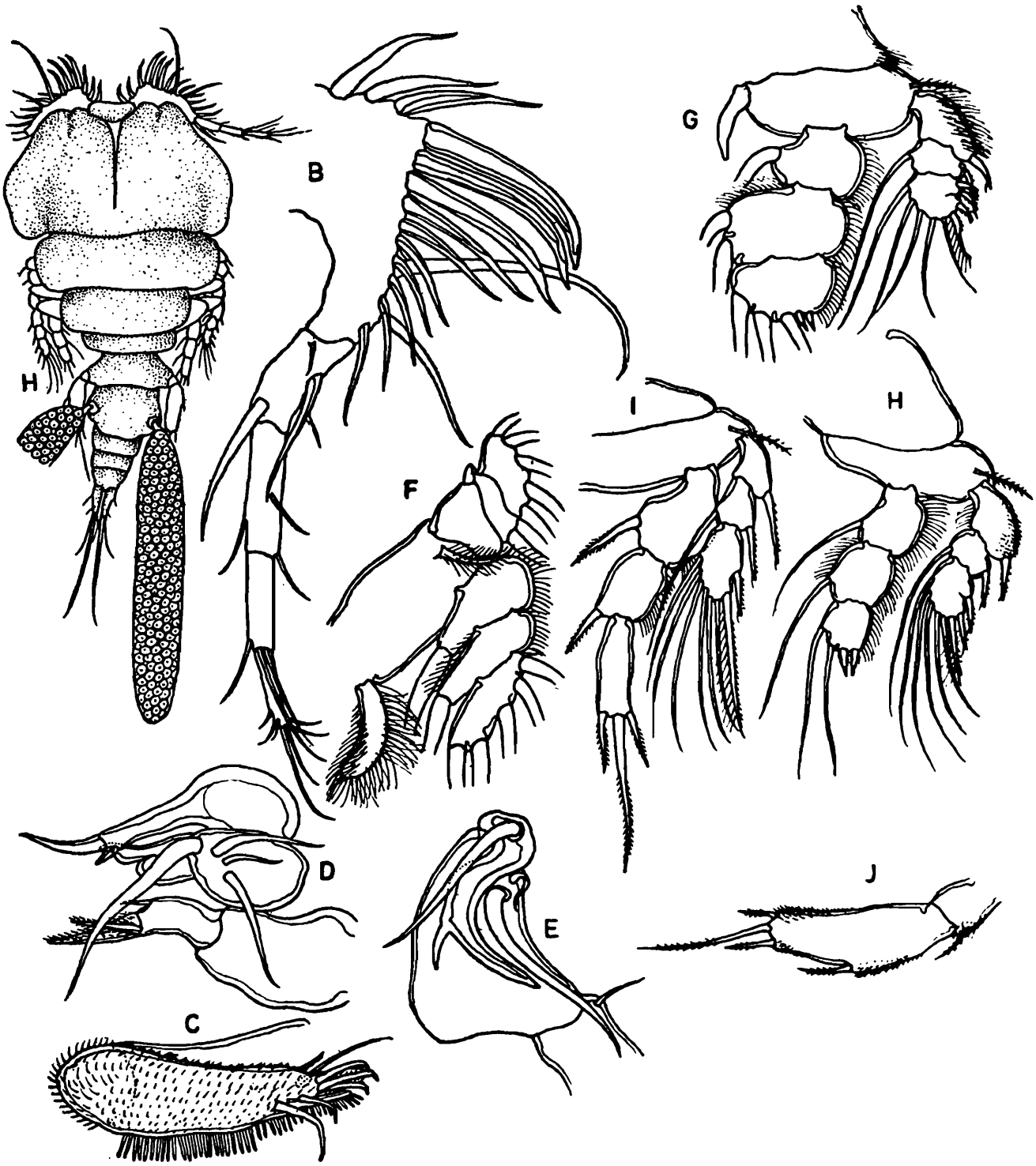


Fig. 5. A-J. *Bomolochus multiceros* Pillai and Natarajan : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible; E, maxillule and maxilla ; E, maxilliped ; F-J, legs 1-5.

*Host.—Psenes indicus*

*Distribution*—India (Kerala).

*Holotype*-female in the National Zoological collection at Zoological Survey of India, Calcutta.

*Remarks.*—In *Bomolochus* only the fourth seta of the antennule gets modified. But in the present species setae four to six are modified and different from the others, resembling the condition in *Nothobomolochus.* In *Nothobomolochus* however setae three to five alone fuse with chitinised processes while in *B. multiceros* proceses fuse with setae three to fourteen showing its affinity with *Bomolochus.* More over the flattening of the endopod of the second leg and the presence of a prominent accessory process on the claw of the maxilliped are reminiscent of the condition in *Bomolochus.*

The arrangement of the setae on the antennule, the long distal blade of the mandible, the very long setae on the exopods of legs two to four, the setation and the long distal claw on the fourth exopod and the armature of the fifth leg easily distinguish this species. *B. multiceros* apparently bridges the gap between *Bomolochus* and *Nothobomolochus* as far as the antennular character is concerned.

## **Bomolochus selaroides** Pillai
(Figs. 6)

*Bomolochus selaroides* Pillai, 1965, p. 47, fig. 19.
*Parabomolochus selaroides* Pillai, 1967*d*, p. 1565, fig. 14.

*Female.*—Cephalothorax roughly semicircular, hind border nearly straight. Rostral lobe projecting. Second thoracic segment with concave hind border. Third segment slightly longer than second, overlapping fourth. Fourth segment overlapping fifth. Fifth segment small, narrower than fourth. Genital segment large, proximally swollen. Abdomen short and fairly stout, rapidly narrowing, anal segment spiny. Dorsal surface of caudal rami spiny, distal inner seta more than twice as long as outer. Egg sacs short and stout, oblong.

Peduncle of antennule highly flattened, claw prominent and projecting well beyond the setae, apically acute and moderately

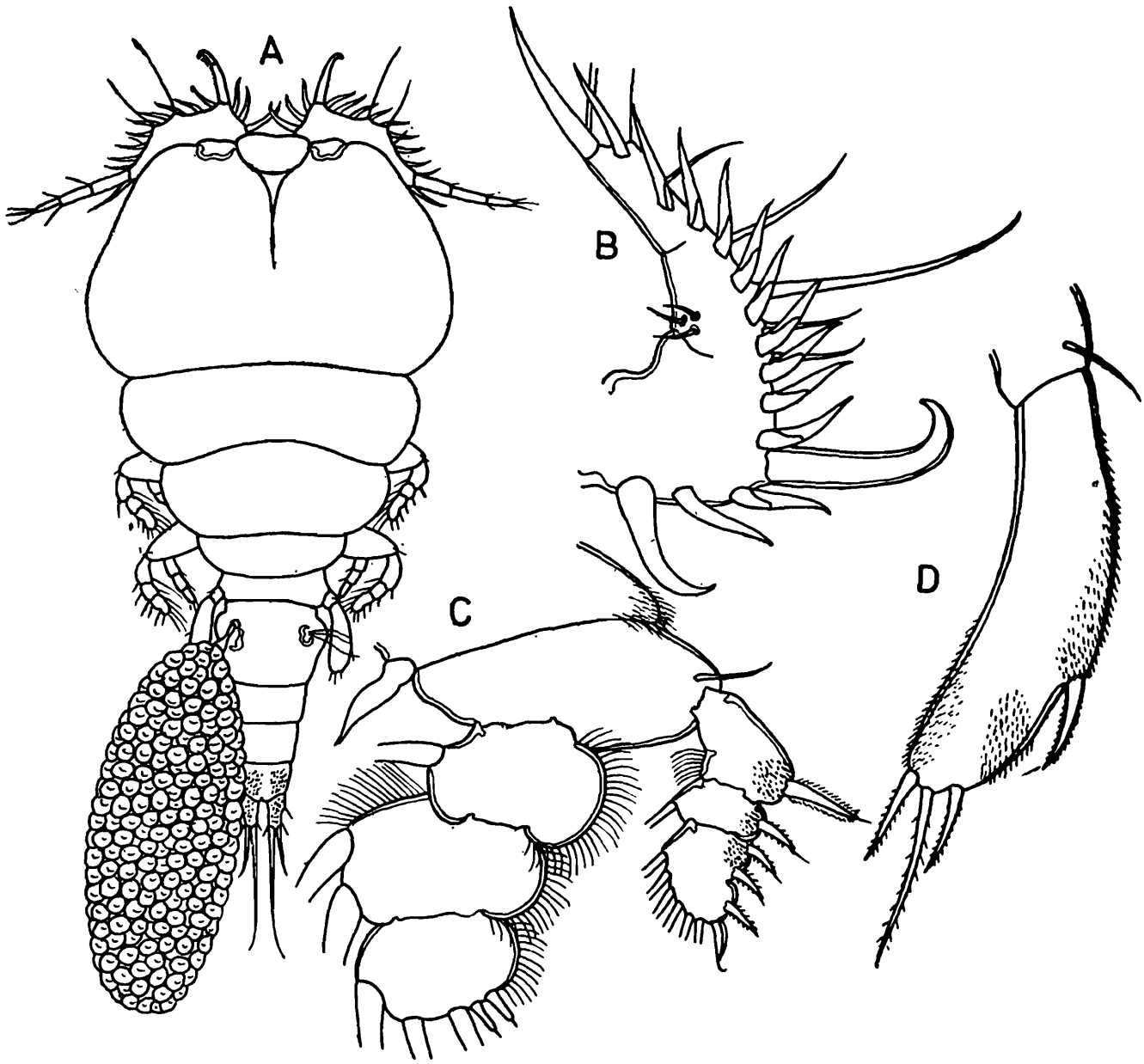


Fig. 6. A-D. *Bomolochus selaroides* Pillai : A, female, dorsal view; B, antennule, C, leg 2 ; D, leg 5.

curved, setae comparatively short. Third segment of antenna with longitudinal rows of denticles, a long ventral row of blunt spines, spiny lamellar process, five claws and one seta. Apical blades of mandible dissimilar, curving upwards. Maxillule with one long and three short setae, paragnath a cylindrical apically rounded process. Second segment of maxilliped only slightly longer than first, claw with prominent accessory process.

Rami of first leg moderately flattened, clearly three-segmented, first two segments of endopod pustulose. Endopod of second leg, especially its second segment, highly flattened, exopod comparatively small, outer surface of segments with microscopic spinules, outer border of first segment naked, first spine very large, with pectinate wings, two to five barbed, sixth winged on outer border. Exopod segments of third leg spiny, claws sparsely toothed on outer side, endopod broader than exopod, apical spines winged and with trigger-like prolongation. Fourth leg with elongated rami, endopod clearly longer than exopod, claws on exopod similar to those on thrid leg, segments of both rami spinulose, apical middle spine on endopod only moderately long, with broad wings. Distal seagment of fifth leg elongated and conspicuously spiny. distal seta long and sparsely pectinate.

*Length.*—2.1 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+I |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Selaroides leptolepis.*

*Distribution.*—India (Kerala).

*Holotype-female* in the National Zoological Collection at Zoological Survey of India, Calcutta. *Reg. No.* C4613/1

## Genus **Holobomolochus** Vervoort

*Holobomolochus* Vervoort, 1969, p. 35.
*Bomolochus* Nordmann, 1832, p. 135.
*Artacolax* Wilson, 1908*b*, p. 433.

*Diagnosis.*—Cephalothorax and the succeeding thoracic segments as in *Bomolochus*, but the former often enlarged. Rostral plate usually without sharp apex. Third thoracic segment often considerably enlarged, overlapping fourth. Genital segment as in *Bomolochus*. First abdominal segment may or may not be telescoped into genital segment. Caudal rami with the two distal setae long.

Antennular peduncle without chitinous plates, consequently all the setae normally developed though the fourth may be slightly different. Third segment of antenna with blunt teeth, occasionally fa ling into longitudinal rows, lamellar process with a row of long spines continued on to the segment, hook at the base of the lamellar process stout. Maxillule with three to four setae. Claw of maxilliped with or without accessory process. Rami of leg one moderately flattened, exopod segments fused, endopod of second and third legs flattened or not, second segment with two inner setae. Spines on exopods with subapical flagellum, their outer margin toothed or spinulose. Distal segment of fifth leg rather short, distally rounded, with slender weak setiform spines.

Male as in *Bomolochus*.

Type-species : *H. nothrus* (Wilson).

*Discussion.*—Vervoort included seven species in this genus : *H. nothrus* (Wilson, 1913), *H. ardeolae* (Kroyer, 1864), *H. attenuatus* (Wilson, 1913), *H. palleucus* (Wilson, 1913). *H. albidus* (Wilson, 1932), *H. acutus* (Gunanamuthu, 1948c) and *H. confusus* (Stock, 1953). To these were subsequently added *H. nemipteri* Pillai (1973), *H. venustus* Kabata (1971), *H. occultus* Kabata (1971), *H. spinulus* (Cressey, 1969), and *H. prolixus* (Cressey, 1969). Only two species are known from Indian waters.

The available description of *H. acutus* (Gnanamuthu) is very unsatisfactory. Its type deposited in the Indian Museum was lost and no other specimen exists. If it cannot be collected and redescribed it will have to be discarded. I am therefore omitting it from the present study.

### **Holobomolochus nemipteri** Pillai
(Fig. 7)

*Holobomolochus nemipteri* Pillai, 1973, p. 487, figs. 1-12.

*Female.*—Cephalothorax comparatively large, only slightly broader than long, frontal sinus narrow, rostral plate slightly projecting. Postero-lateral parts of cephalothorax rounded, hind border nearly

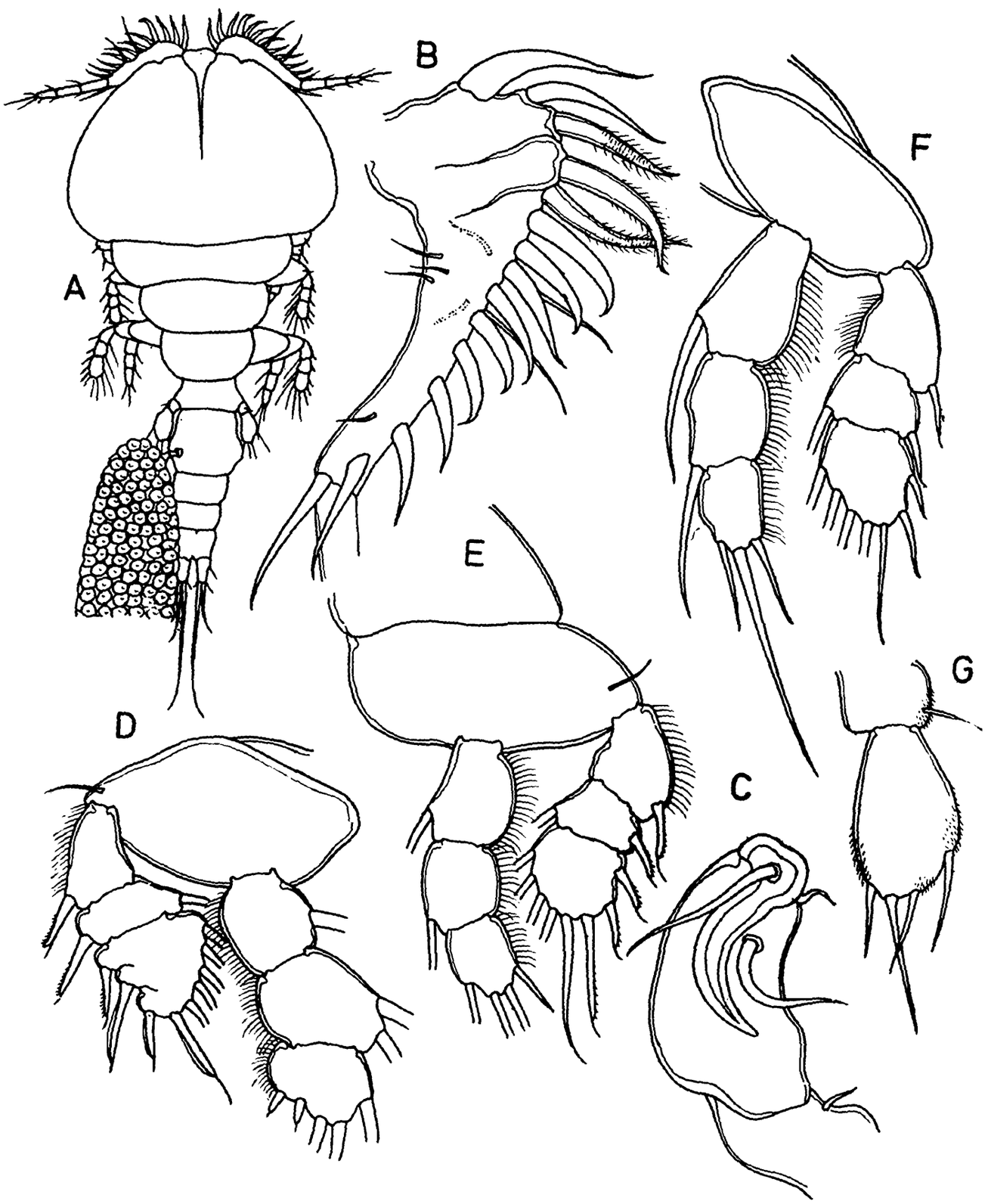


Fig. 7. A-G. *Holobomolochus nemipteri* Pillai : A, female, dorsal view ; B, antennule ; C, maxilliped ; D-G, legs 2-5.

straight. Second thoracic segment much narrower than cephalothorax, postero-medially concave, next two segments successively narrowing. Fifth segment as broad as genital segment, latter subequal in length and width. Abdomen short and slender. Inner distal seta on caudal rami thrice as long as outer. Post-cephalothoracic part of body comparatively slender.

Peduncle of antennule deep, segments fused, fourth seta slightly stouter than adjacent ones, apically curved and sparesely hirsute. Smooth setae two in number, short. Distal segment of antenna with scattered spinules, a marginal long row of long spines, lamellar process, six claws and one seta. Distal blade of mandible long and slender, subapical blade small. Maxilla with stout basal segment, distal blades dissimilar. Second segment of maxilliped irregularly oblong, claw stout and moderately curved, accessory claw absent.

Rami of first leg highly flattened, exopod comparatively long, with fairly distinct segmentation, spine on basal segment stout, endopod very broad, but segments short. Rami of second leg moderately flattened, third exopod segment and second endopod segment broadest, claws on exopod large, externally spinulose. Exopod of third leg slightly broader than endopod, second endopod segment with one seta, third segment with three setae and one spine. Rami of fourth leg flattened, endopod longer, claws on exopod setiform, third endopod segment narrowing, apical setae long and slender, median two and a half times as long as the lateral. Basal segment of fifth leg comparatively large, distal spatulate, with setiform spines and a long seta.

*Length.*—1.1. mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 1+I, 5+III |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 3+I | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Nemipterus japonicus.*

*Distribution.*—India (Kerala).

*Holotype*—female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2101/2.

*Remarks.*—*H. nemipteri* is apparently an aberrant member of the genus. In *Holobomolochus* the second endopod segment of legs two and three carries two inner setae, but in *H. nemipteri* the third leg has only one seta. The third segment of the same ramus usually carries two spines and two setae but there are three setae and one spine in *H. nemipteri*. The antennular base appears to have an indistinct chitinous plate in line with the fourth seta.

## Genus **Nothobomolochus** Vervoort

*Nothobomolochus* Vervoort, 1962, p. 58.
*Pseudobomolochus* Yamaguti, 1939*a*, p. 398.

*Diagnosis.*—Cephalothorax anteriorly rounded and posteriorly subtruncate, antero-median part with prominent V-shaped groove in continuation with the base of the rostral plate. Thoracic segments succeessively narrowing and merging gradually into the abdomen (third segment often enlarged and completely covering fourth). Abdomen short, half the length of cephalothorax or shorter. Caudal rami with six setae.

Setae three to five of antennular base fused with chitinous plates and modified into strong spine-like processes varying in shape, flagellum three-to four-segmented. Third segment of antenna with spines often falling into longitudinal rows, a small swelling with longer spines at the base of the lamellar process, five hooks and one seta. Mandible as in *Bomolochus*. Maxillule with four setae, two short and two long. Maxilla as in *Bomolochus*. Maxilliped with strong claw, with or without accessory process. Rami of leg one flattened, endopod of second flattened. Fifth leg as in *Bomolochus*.

Male as in *Bomolochus*.

Type-species : *N. managatuwo* (Yamaguti).

*Discussion.*—Vervoort included eleven species in this genus:—*N. managatuwo* (Yamaguti, 1939*a*), *N. scomberescosis* (Kroyer,

1864), *N. cornutus* (Claus, 1864), *N. saetiger* (Wilson, 1911a), *N. triceros* (Bassett-Smith, 1898a), *N. denticulatus* (Bassett-Smith, 1898b), *N. multispinosus* (Gnanamuthu, 1947c), *N. cypseluis* (Yamaguti, 1953), *N. gibber* (Shiino, 1957d), *N. lateolabracir* (Yamaguti and Yamasu, 1959), and *N. epulus* Vervoort (1962). To these were added *N. kanagurta* (Pillai, 1965) *N. quadriceros* Pillai (1973), *N. gerresi* Pillai (1973), and *N. digitatus* Cressey and Collette (1970). Out of these fifteen species nine are known from Indian waters and I am adding one more species, *N. trichiuri*. As Vervoort (1962) observed doubt regarding the correctness of Thomson and Scott's (1903) record of *N. scomberesocis* from Ceylon I have omitted it from the present study.

*Key to the species of* **Nothobomolochus**

1. Processes on antennule subequal in size and shape ... ... ... ... ... ... ...2
— Processes on antennule unequal in size and shape ... ... ... ... ... ... ...7
2. All processes apically drawn out and pointed ... ... ... ... ...*digitatus* Cressey and Collette
— Median process apically blunt, others drawn out and pointed ... ... ... ... ... ...3
— All processes apically blunt ... ... ... ...*gerresi* Pillai
3. Naked seta outer to third process as stout as third process ... ... ... ...*quadriceros* Pillai
— Naked seta outer to third process slender ... ... ... ...4
4. Naked seta outer to third process much longer than process ... ... ... ... *multispinosus* (Gnanamuthu)
— Naked seta outer to third process as long as or only slightly longer than process ... ... ... ...5
5. Processes short but placed on a high pedestal ... ... ... ... ... ...*denticulatus* (Bassett-Smith)
— Processes long ... ... ... ... ... ...6
6. Third thoracic segment completely overlapping fourth ... ... ... ...*kanagurta* (Piillai)
— Third thoracic segment only partially overlapping fourth ... ... ... ...*triceros* (Bassett-Smith)
7. Second thoracic segment much narrower than third ... ... ... ... ...*gibber* (Shiino)
— Second thoracic segment as broad as or broader than third ... ... ... ... ... ...8

8. Distal segment of leg five distally broadened, claws on exopod of legs two to four externally toothed ... ... ... ...*trichiuri* Pillai and Natarajan

— Distal segment of leg five distally narrowed, claws on exopod of legs to four naked ... ...*cypseluri* (Yamaguti)

## **Nothobomolochus cypseluri** (Yamaguti)
(Fig. 8-9)

*Bomolochus (Artacolax) cypseluri* Yamaguti, 1953, p. 224, pl. 2, fig. 19, pl. 3, ffgs. 20-27, pl. 4, fig. 28.

*Artacolax cypseluri* Shiino, 1957a, p. 417, 422; Yamaguti and Yamasu, 1959, p. 92.

*Pseudartacolax cypseluri* Yamaguti, 1963, p. 14, pl. 11, fig. 1.

*Nothobomolochus cypseluri* Vervoort, 1962, p. 69; Pillai and Natarajan, 1977, p. 26, figs. 30-42.

*Female.*—Cephalothorax large, with irregular borders, postero-laterally produced into prominent lobes overlapping second segment, posterior border between lateral lobes forming a hyaline extension over the second segment. Dorso-median rib almost reaching hind border of cephalothorax. Second thoracic segment transversely oblong, postero-laterally produced into triangular lobes overlapping third segment, latter roughly semicircular, postero-medially slightly produced, fully hiding fourth segment. Fifth segment short, genital segment as broad as fifth segment, equal in length and width. Abdomen moderately long. Caudal rami suddenly narrowed beyond the outer seta, apical inner seta more than twice as long as outer. Egg sacs long and stout, as long as pregenital part of body.

Peduncular segments of antennule fully fused, with twelve plumose setae, three chitinised processes and five naked setae. First and fifth naked setae of the same length, fourth very long, others short. First chitinised process short and slender, smaller than the smallest seta, its surface rugose. Second and third processes stout, subsimilar and strongly chitinised. Distal segment of antenna with scattered, prominent hook-like spines, lamellar process and the bulge at its base with longer spines, there are four hooks and a seta, the hook at the base of the lamellar process stout, with a subapical tooth. Mandible comparatively small, with large apical and small subapical spiny blades. Maxillule with

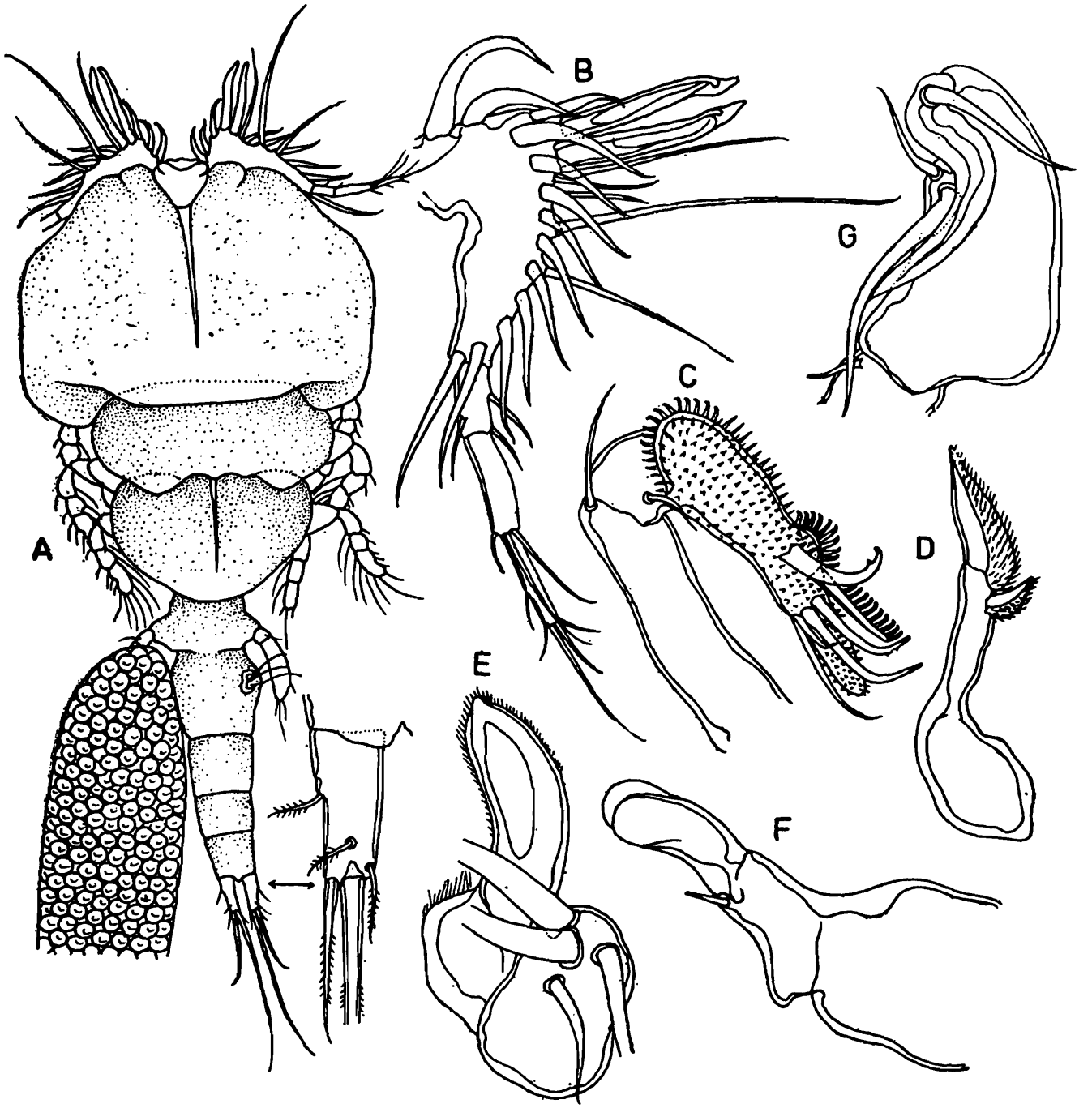


Fig. 8. A-G. *Nothobomolochus cypseluri* (Yamaguti) : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxilla ; G, maxilliped.

two stout and two slender setae. Paragnath cylindrical, slightly curved and distally hirsute. Maxilla with spatulate distal process (processes ?) and a spinule. Claw of maxilliped strong, without accessory process, inner distal seta on second segment comparatively long.

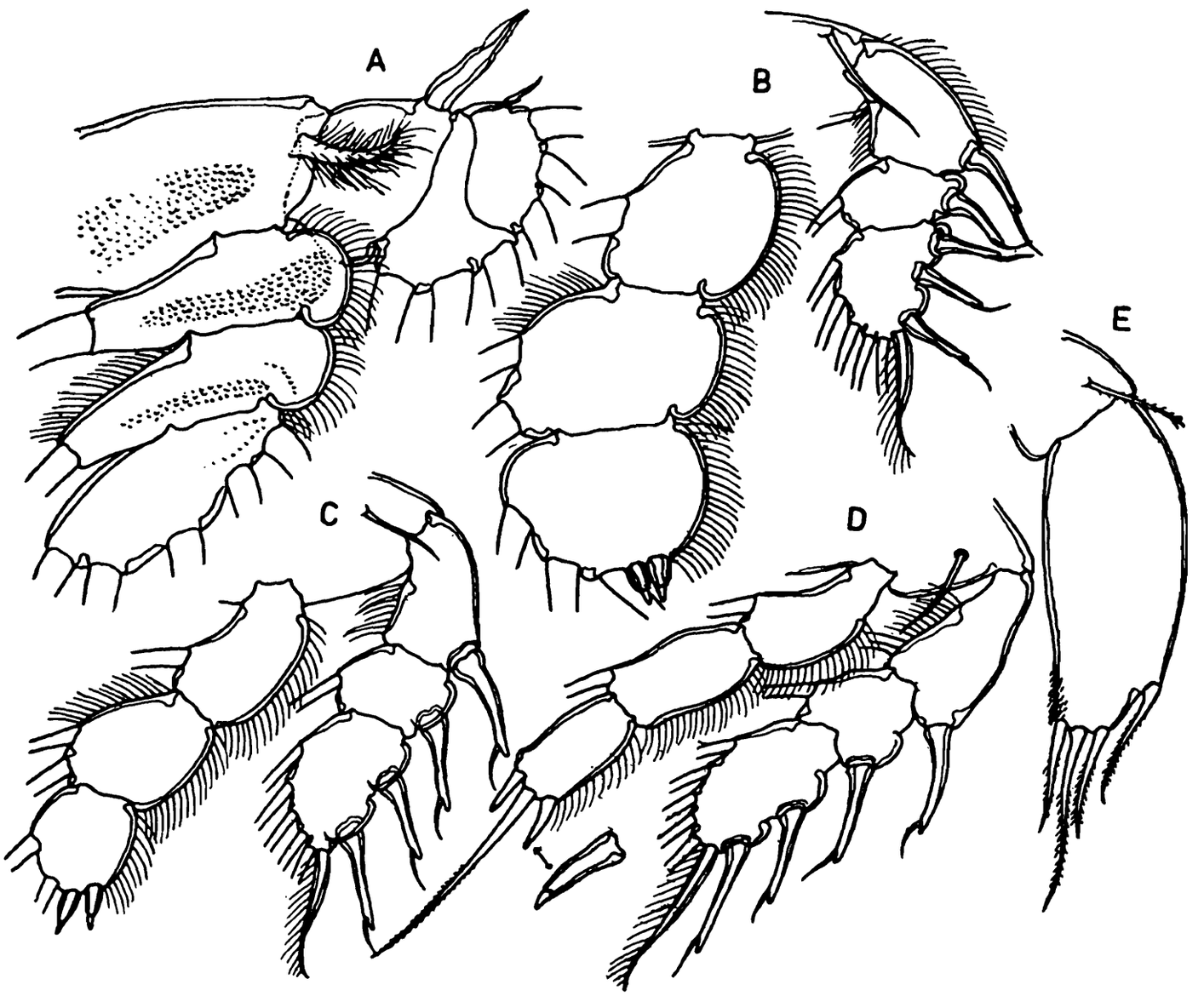


Fig. 9. A-E. *Nothobomolochus cypseluri* (yamaguti) (contd.) : A-E, legs 1-5.

Rami of first leg flattened and three-jointed, first two endopod segments with patches of pustules, first segment of exopod with large claw having hyaline distal half, next two segments with one slender spine each. Basal segment of exopod of second leg with hairy borders, claws arming the segments naked, with subapical setule, last claw externally winged, endopod flattened, spines on third segment with hyaline apical prolongation. Rami of third leg subequal, claws and spines like those on second leg. Rami of fourth leg elongated, endopod particularly so, narrower than exopod, third segment with two spines similar to those on previous leg but longer and a long pectinate spine. Proximal segment of fifth leg with a seta and a small patch of spinules, distal segment

elliptic, suddenly narrowed beyond outer spine, with pustules and spinules, spines setiform and pectinate, seta very long.

*Length.*—2.3 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+I |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 5+III |

*Host.*—*Cypselurus* sp., *C. agoo.*

*Distribution.*—Japan, India (Kerala).

*Remarks.*—Yamaguti's description of this species is substantially correct but lacks details. These have been supplied in the present description. *N. cypseluri* has a restricted distribution in the Indo-Pacific.

### **Nothobomolochus denticulatus** (Bassett-Smith)
(Fig. 10)

*Bomolochus denticulatus* Bassett-Smith, 1898b, p. 78, pl. 3, fig. 1; 1899, p. 433; Gnanamuthu, 1947c, p. 318; Sewell, 1949, p. 149; Pillai 1965, p. 41, fig. 16.

*Nothobomolochus denticulatus* Vervoort, 1962, p. 65; Pillai, 1967d, p. 1567, fig. 18; 1969, p. 151, figs. 5-8.

*Female.*—Cephalothorax semicircular, hind border nearly transverse, rostrum not much projecting. Second thoracic segment posteriorly rounded, only very slightly narrower than cephalothorax, the two together forming a circle. Third segment comparatively very large, hiding fourth segment and nearly half of the fifth segment. Latter much broader than long. Genital segment very broad. Abdomen short but stout. Apical median seta of caudal rami stout, much longer than the outer. Egg sacs long and cylindrical, as long as the body.

Chitinous plate on antennule large and projecting, first and third processes apically drawn out and acute, with rugose surface, median process stouter, apically blunt and recurved. First two naked setae long and subsimilar. Third segment of antenna with scattered spines, lamellar process with a bulge near its base, hooks as usual in the genus. Mandible with subequal blades. Maxillule with two large and one small setae. Paragnath dorsally hairy and ventrally

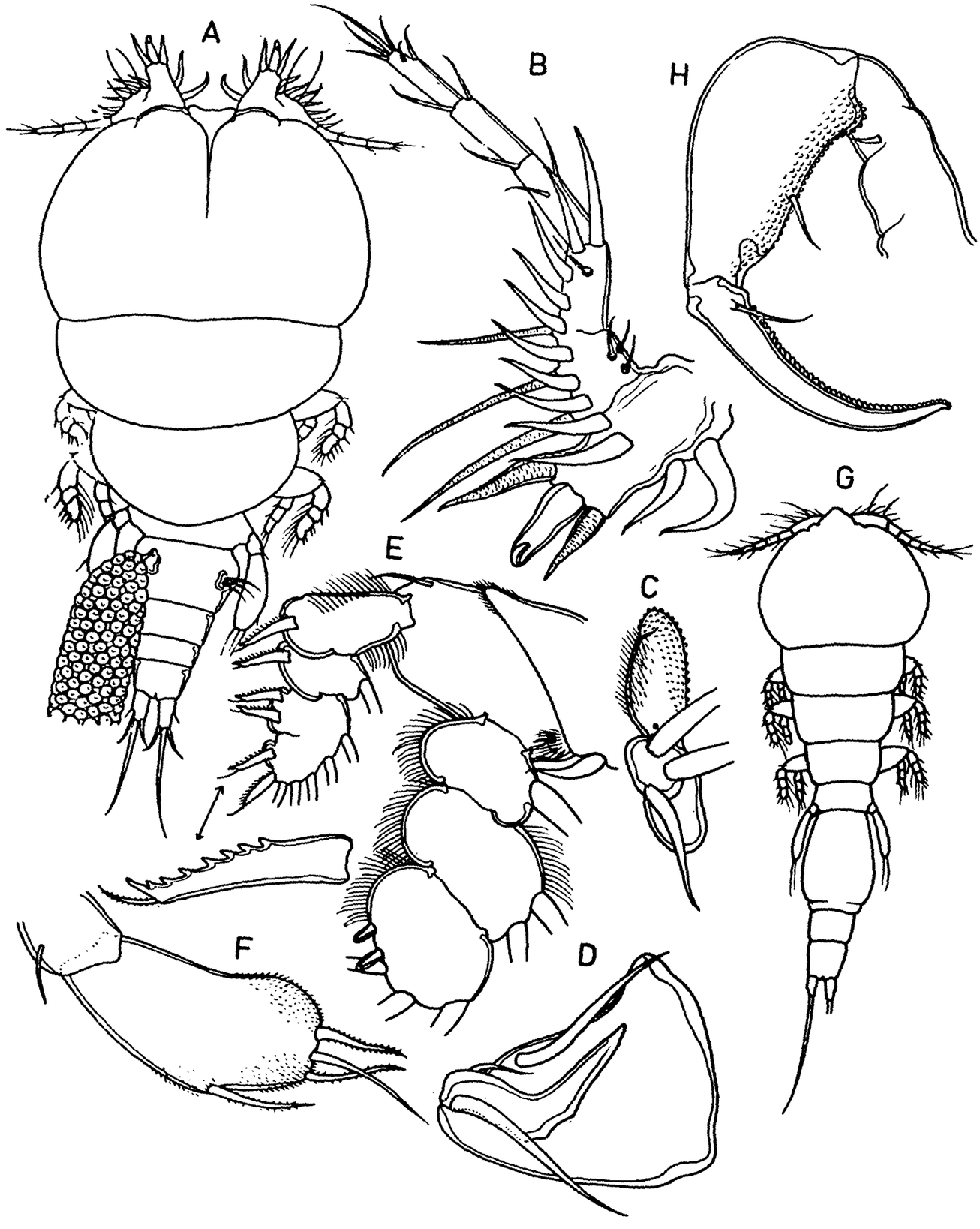


Fig. 10. A-H. *Nothobomolochus denticulatus* (Bassett-Smith) : A, female, dorsal view ; B, antennule ; C, maxillule ; D, maxilliped ; E, leg 2 ; F, leg 5 ; G, male, dorsal view ; H, maxilliped (male).

spiny. Maxilla with globular basal segment, blades barbed. Claw of maxilliped stout but short, moderately curved, outer border forming four low projections.

First leg with flattened three-segmented rami, first two endopod segments pustulose. Endopod of second leg moderately flattened, spines on third segment winged. Claws on exopod externally denticulated. Rami of third leg of the same width, spines on third endopod segment blunt, those on exopod denticulated. Endopod of fourth leg narrower than exopod, inner setae spine-like, distal lateral spines blunt, median long. Distal segment of fifth leg distally expanded and rounded, spines pectinate and setiform, seta naked.

*Length.*—2.6 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+I, |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Male.*—Body rather elongated. Cephalothorax nearly circular, with projecting triangular rostrum, thoracic segments two to five regularly narrowing. Genital segment broader than fifth thoracic segment, broadest behind. First segment of abdomen fused with genital segment. Apical seta on caudal rami longer than abdomen. Second segment of maxilliped stout, with one inner seta, inner surface pustulose, distal segment longer than second, with a long proximal seta. Distal segment of fifth leg slender, with two long slightly unequal spines, and an inner patch of spinules.

*Length.*—1.3 mm.

*Host.*—*Sphyraena jello, Hemirhamphus far.*

*Distribution.*—Sri Lanka, India (Kerala).

*Remarks.*—Kirtisinghe (1964) considered *N. denticulatus* a synonym of *N. scomberesocis.* As already pointed out the record of the latter from Indian waters is doubtful. As the British Museum specimens collected by Bassett-Smith are slightly different from those described here Kirtisinghe's opinion may perhaps turn out to be correct.

The processes on the antennule are quite unlike those of any other species. Together with this the denticulated claws on the legs and the large third thoracic segment serve to distinguish this species.

### **Nothobomolochus digitatus** Cressey and Collette

*Nothobomolochus digitatus* Cressey and Collette, 1970, p. 374, figs. 102-112.

*Female.*—Cephalothorax comparatively very large, posterolaterally produced into large lobes making the hind border highly concave and somewhat overlapping second thoracic segment. Latter much narrower than cephalothorax. Third segment transversely oblong, completely overlapping the fourth and genital segments and even a part of the abdomen. Abdomen fairly stout and long, first two segments subequal in length, third very small. Caudal rami longer than broad, distal median seta stout, others very small.

Setae three to five on antennule modified into stout but short identical processes, each distally produced into an acute hyaline process. Antenna as in *N. gibber*. Mandible with subequal processes, apical process acute, subapical blunt, both ventrally pectinate. Maxillule with four setae, one of them very small and naked, paragnath distally produced into nine finger-shaped processes with swollen tip, processes decreasing in length backwards. Maxilla ending in two blades and a sharp spine, upper blade ventrally pectinate, lower with ventral row of spines. Second segment of maxilliped triangular, equal in length and width, with two large and one small claw, claw nearly straight, without accessory process.

Basal segment of fifth leg with one seta, distal segment with distal inner patch of denticles, a long seta and three setiform spines, all naked. Legs one to four with the following armature.

*Length.*—1.8 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 6+III |
| Leg 2 | 1+0, 2+0, 3 + II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 1+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 0+0, I+1+I | 0+I, 1+I, 4+III |

*Host.—Strongylura leiura, S. strongylura, Tylosurus crocodilus, T punctulatus.*

*Distribution.*—Indo West Pacific (Gulf of Thailand, Philippines, Java, India, Hongkong, Australia, New Guinea).

*Holotype.*—Female in the U.S. National Museum.

*Remarks.*—This species is unique as practically every character is very diagnostic. The general shape of the body, the shape of the chitinous processes on the antennule and the digitiform processes on the paragnath of the maxillule are particularly noteworthy.

## **Nothobomolochus gerresi** Pillai
(Fig. 11)

*Nothobomolochus gerresi* Pillai, 1973, p. 493, figs. 25-32.

*Female.*—Cephalothorax comparatively very large, with short dorso-median rib, postero-laterally prominently bulged. Rostrum projecting. Second thoracic segment much narrower than cephalothorax, third still narrower, almost completely overlapping fourth segment. Fifth segment very short. Genital segment as broad as fifth segment. Abdomen short but stout. Caudal rami with long stout apical seta, other setae very small.

Processes on antennule subsimilar, apically blunt and curving outwards, successively increasing in length. Naked setae one and four large, subequal in length. Distal segment of antenna large, with scattered large spinules, linguiform process fairly large, lamellar process bulged at its base, hooks and setae well developed, hooks four, setae two, spines on lamellar process sharp. Mandible stout, distal blade much larger than subapical. Maxillule with two stout and two small setae. Paragnath long, cylindrical and apically rounded and naked. Basal segment of maxilla very large, apical blades dentate. Maxilliped with stout slightly curved claw, proximal outer part of second segment angular.

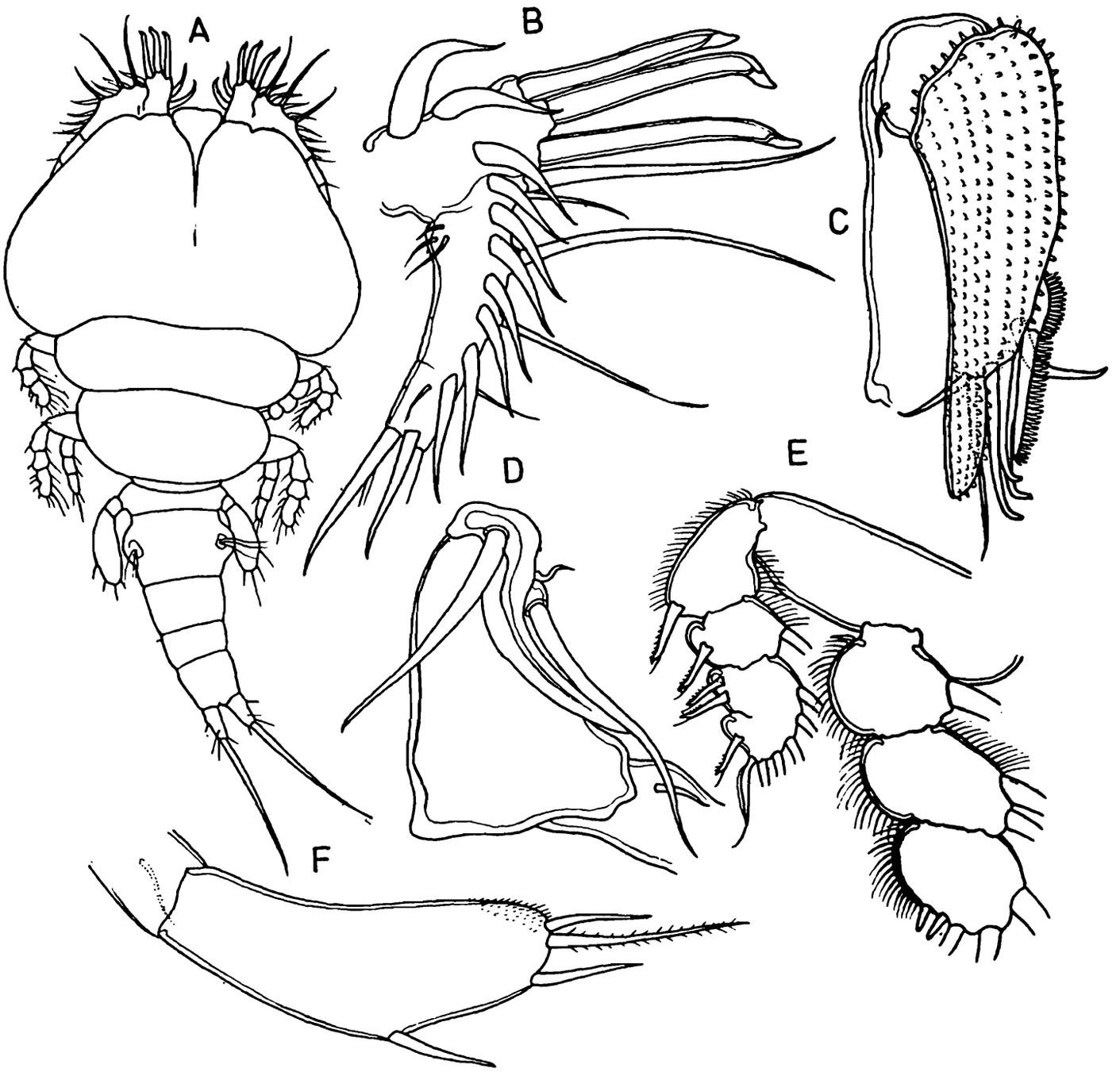


Fig. 11. A-F. *Nothobomolochus gerresi* Pillai : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxilliped ; E, leg 2 ; F, leg 5.

Rami of first leg highly flattened, exopod segments partially fused, first and third segments with a spine consisting of a swollen base and slender distal part. Endopod of second leg only moderately flattened, broader than exopod, claws on exopod with a few distal outer teeth. Rami of third leg of the same width, claws on exopod similar to but longer than those on second leg. Spines on third endopod segment with small apical prolongation. Fourth leg comparatively very small, endopod narrower than exopod. Distal

segment of fifth leg elongated, spines weak and long, seta very long, sparsely pectinate.

*Length.*—1.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+0, 3+I, |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Gerres filamentosus*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Z. S. I., Calcutta. Reg. No. C 2102/2.

*Remarks.*—The disproportionately large cephalothorax, sparsely dentate claws on the legs and the uniformly blunt processes on the antennule easily distinguish this species. The setation of the caudal rami is also very characteristic.

**Nothobomolochus gibber** (Shiino)
(Fig. 12)

*Bomolochus gibber* Shiino, 1957d, p. 411, figs. 1-2.

*Nothobomolochus gibber* Vervoort, 1962, p. 70; Cressey and Collette, 1970, p. 372, figs. 99-101; Pillai and Natarajan, 1977, p. 24, figs. 21-29.

*Pseudartacolax gibber* Yamaguti, 1963, p. 14, pl. 8, fig. 1.

*Female.*—Cephalothorax comparatively large, with irregular borders, nearly twice as broad as long, postero-lateral parts produced into large lobes embracing and slightly overlapping second thoracic segment. Latter two thirds as broad as cephalothorax, very short and immersed in the latter. Third thoracic segment large, much broader than second, posteriorly produced into a lobe fully covering the fourth and fifth segments and a part of the genital segment, antero-laterally rounded. Genital segment nearly as long as broad. Abdomen comparatively very short, third segment abruptly narrowed distally. Caudal rami sharply narrowing, apical

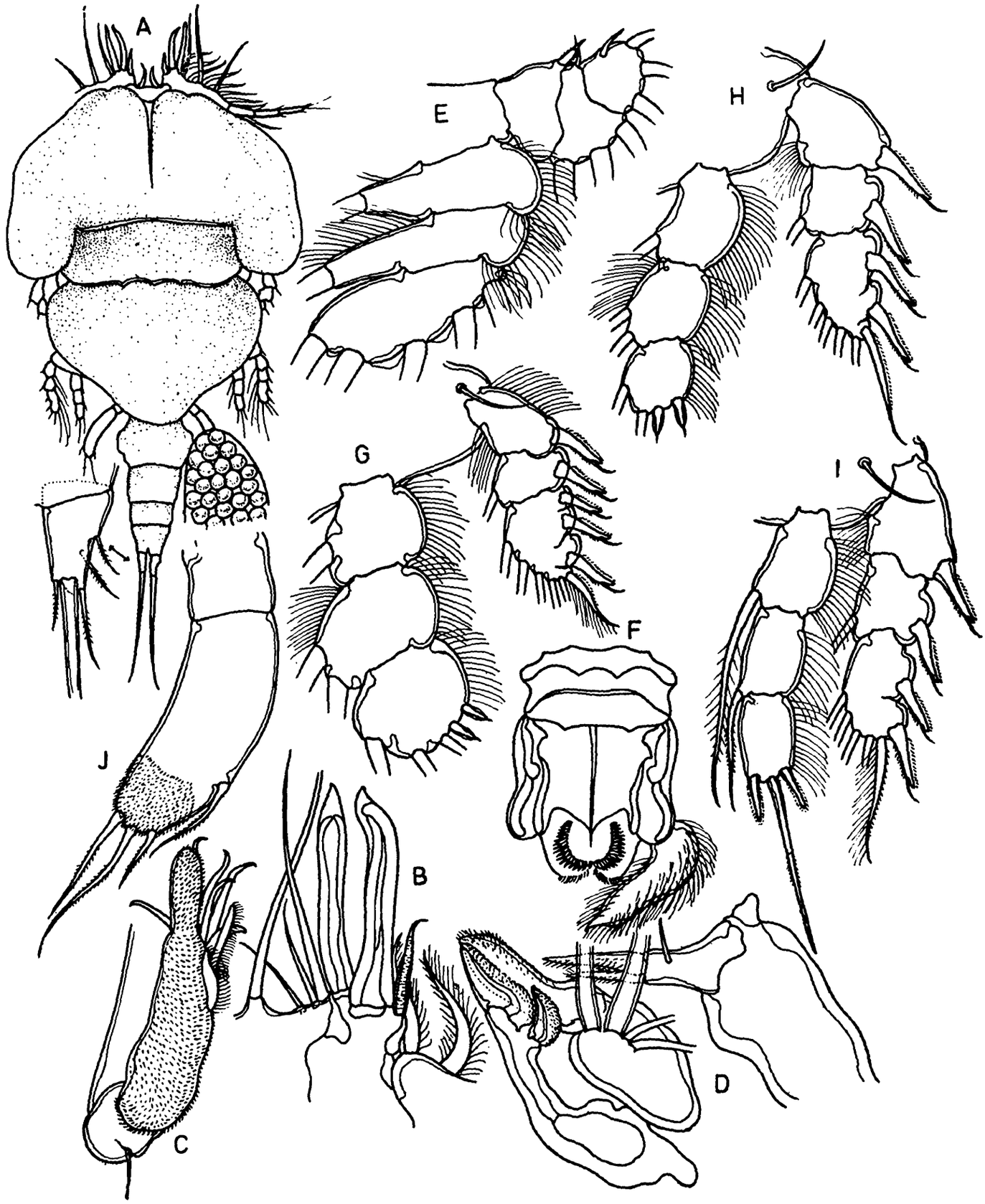


Fig. 12. A-J. *Nothobomolochus gibber* (Shiino) : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible, maxillule and maxilla ; E, leg 1 ; F, same, intercoxal plate ; G-J, legs 2-5.

seta very long. Egg sacs as long as the body including the long seta on the caudal rami.

Antennule similar to that of *N. cypseluri* but first process bent inwards and the others outwards and apically broader. Third segment of antenna generally as in *N. cypseluri* but the spinules smaller, lamellar process shorter, linguiform extension distally broader, the large claw at the base of the lamellar process without a subapical tooth.

Distal blades of mandible armed with coarse tubercles or blunt spines. Maxillule with two large and two small setae. Paragnath apically acuminate and coarsely spiny. Maxilla with two barbed blades. Maxilliped as in *N. cypseluri*, with outer hump as shown by Cressey and Collette.

Rami of first leg clearly three-jointed, endopod segments internally produced, marginal chitinisation between setae unusually prominent, first spine on exopod apically drawn out into a sharp hyaline process, its base stout and spiny. Endopod of second leg moderately flattened, distal spines on third segment with serrate wings and an apical spinule. Both borders of first exopod segment hairy, claws armed on both sides with fine spinules, apical spine drawn out into a filament. Endopod of third leg narrower than exopod, latter stouter than that of second leg, with stouter claws. Inner seta on basal segment of endopod of fourth leg reaching tip of lateral spine on third segment, latter with very long median spine, exopod broader than endopod. Basal segment of fifth leg squarish, apparently without armature, distal segment with subparallel sides, surface beyond the outer spine fully spiny, spines similar to the seta.

*Length.*—2.3 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+I |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Tylosurus giganteus, T acus, T crocodilus, Belone belone, B. svetovidovi, Platybelone argalus, Ablennes hians.*

*Distribution.*—Japan, India (Kerala), Mediterranean, Eastern Atlantic, Red Sea, Indo West Pacific.

*Holotype.*—Female in the Prefectural University of Mie, Japan.

*Remarks.*—The unusually narrow second thoracic segment of this species is a unique character. Among other distinguishing characters may be mentioned the inwardly curved first antennular process and the uniform spinulation of the tip of the fifth leg.

The present specimens show certain differences from previous records. The second thoracic segment has three posterior projections. The egg sacs are longer. The median prolongation of the intercoxal plate of the first legs is not conical but rounded and prominently bilobed as shown by Cressey and Collette. The exopod of the first leg has in all three spines. The seta on the first endopod segment of fourth leg is much longer. The digitiform process on the basipod of leg one is apically drawn out into a spine as shown by Shiino and not apically rounded as illustrated by Cressey and Collette.

### **Nothobomolochus kanagurta** (Pillai)
(Fig. 13)

*Bomolochus kanagurta* Pillai, 1965, p. 51, fig. 21.
*Nothobomolochus kanagurta* Pillai, 1967d, p. 1568, fig. 20.

*Female.*—Cephalothorax comparatively short, with deep antero-median sinus and short median rib. Second thoracic segment short, nearly as broad as cephalothorax. Third segment large, completely hiding fourth and a part of the fifth segment, latter short, as broad as genital segment. Genital segment broader than long. Abdomen very short, but moderately broad. Caudal rami narrowing, with short but stout apical seta. Egg sacs comparatively short, narrowing distalwards.

Peduncle of antennule made to appear deep by the prominently projecting chitinous plate carrying the three processes. Lateral

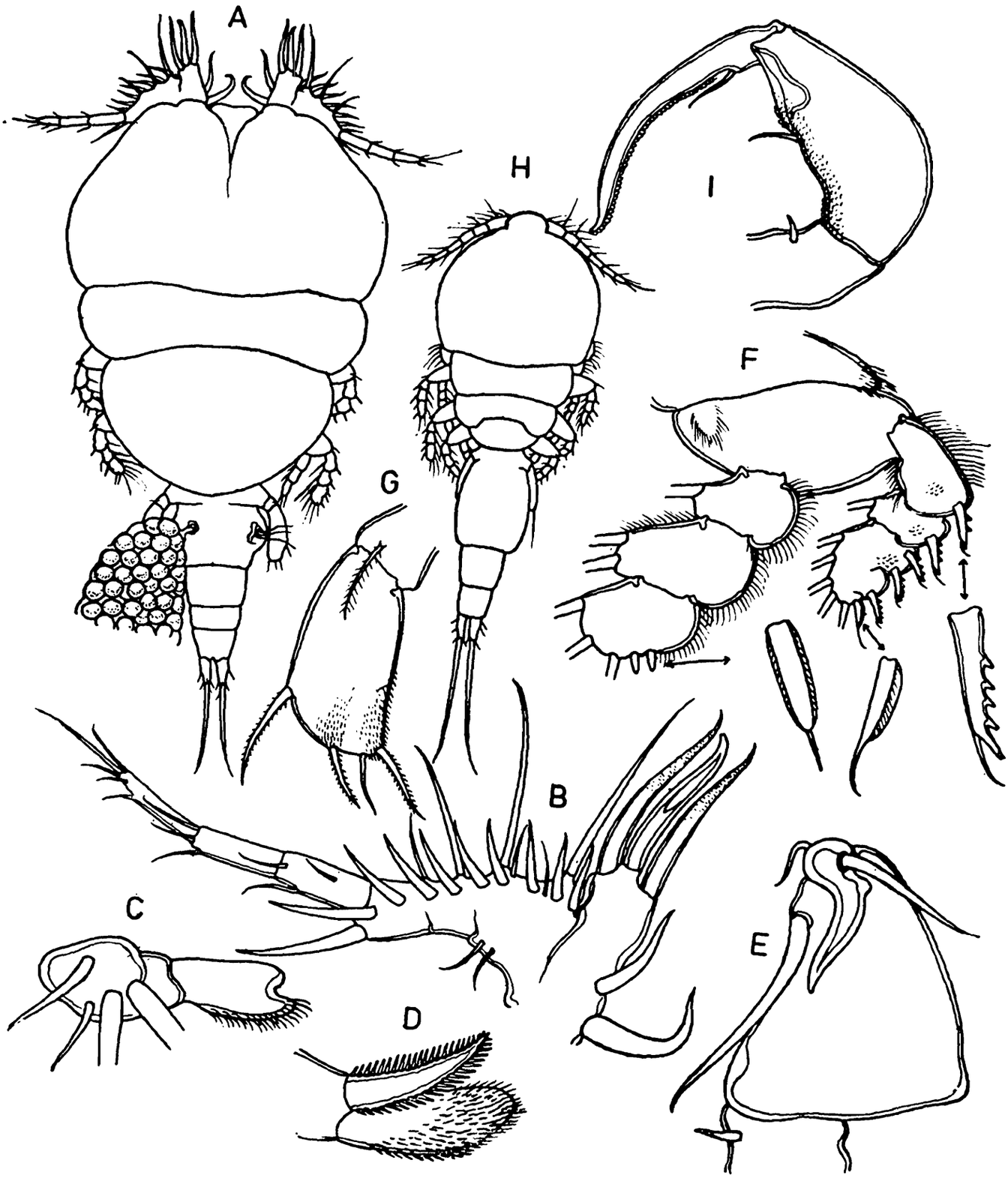


Fig. 13. A-I. *Nothobomolochus kanagurta* (Pillai) : A, female, dorsal view ; B, antennule ; C, maxillule ; D, maxilla ; E, maxilliped , F, leg 2 G, leg 5 , H, male, dorsal view ; 1, maxilliped (male).

processes subsimilar, distally narrowed and drawn out, placed at a lower level than the median, median process well chitinised and shorter than the lateral, apically blunt and slightly curved. Naked seta just outside the third process longest, overreaching the process. Third segment of antenna with logitudinal rows of denticles, two setae and four claws, lamellar process and the bulge at its base with longer spines.

Mandible with slender, subsimilar ventrally toothed blades. Maxillule with two large and two small setae. Paragnath broadening distalwards, its apex bifid and lower part hairy. Maxilla ending in a narrow barbed process and a spatulate broad lobe with spiny surface. Second segment of maxilliped broad, nearly equal in length and width, claw very short, with proximal outer blunt projection.

Endopod of first leg highly flattened, exopod indistinctly three-jointed, basal segment with a swollen prickly spine ending in a setule, third segment with a small blunt spine and a small spinule. Endopod of second leg moderately flattened, spines on third segment roughly cylindrical, winged and with apical spinule, claws on exopod externally with a few strong teeth. Endopod of third leg broader than exopod, armature as in second leg, lower outer angle of basal protopod segment with a crest of spines. Fourth leg with subequal rami, setae on endopod short and spiniform, spines on third segment with pectinate wings. Fifth leg short, distal segment with a characteristic shape, with setiform long spines, seta very short and slender

*Length.*—2.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+II |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Male.*—Cephalothorax large, equal in length and width, with distally rounded rostrum, broader than long. Second and third thoracic segments with rounded sides, fourth segment distally rounded, overlapped by third, much narrowed, fifth segment short, basally very narrow. Genital segment longer than broad, with

evenly convex sides. Abdomen as long as genital segment. Second segment of maxilliped with its proximal two-thirds pustulose and with one seta, distal segment long, with a basal seta, apex curved outwards.

*Length.*—1.4 mm.

*Host.—Rastrelliger kanagurta.*

*Distribution.*—India (Kerala).

*Holotype* female and *Paratype* male in the National Zoological collection at Zoological Survey of India, Calcutta. Reg. No. C 4616/1 & C 4617/1.

*Remarks.*—This species resembles *N. triceros* in the nature of the antennular processes. But in *N. triceros* the processes are appreciably more slender and subequal in length. The claws on the exopod of legs two to four in *N. triceros* are denticulated on both sides and the spines on the fifth leg are stouter. The large third thoracic segment, the very short claw on the maxilliped, the apically bifid paragnath and the spatulate apical process of the maxilla and the short fifth leg distinguish *N. kanagurta.*

## **Nothobomolochus multispinosus** (Gnanamuthu)
(Fig. 14)

*Bomolochus multispinosa* Gnanamuthu, 1947c, p. 309, figs. i-5; Pillai, 1965, p. 45, fig. 18.

*Nothobomolochus multispinosus*, Vervoort, 1962, p. 68 ; Pillai, 1967d, p. 1568, fig. 19.

*Female.*—Cephalothorax large, one and a half times as broad as long and laterally bulged. Antero-median sinus deep and dorso-median rib prominent. Second and third thoracic segments successively narrowing, laterally rounded, latter overlapping fourth segment. Fourth segment very narrow, transversely rectangular. Fifth segment as broad as fourth. Genital segment large, nearly as long as broad, medially bulged. Abdomen short but stout, segments subequal in length but successively narrowing. Caudal rami longer than anal segment, with five setae, median distal seta

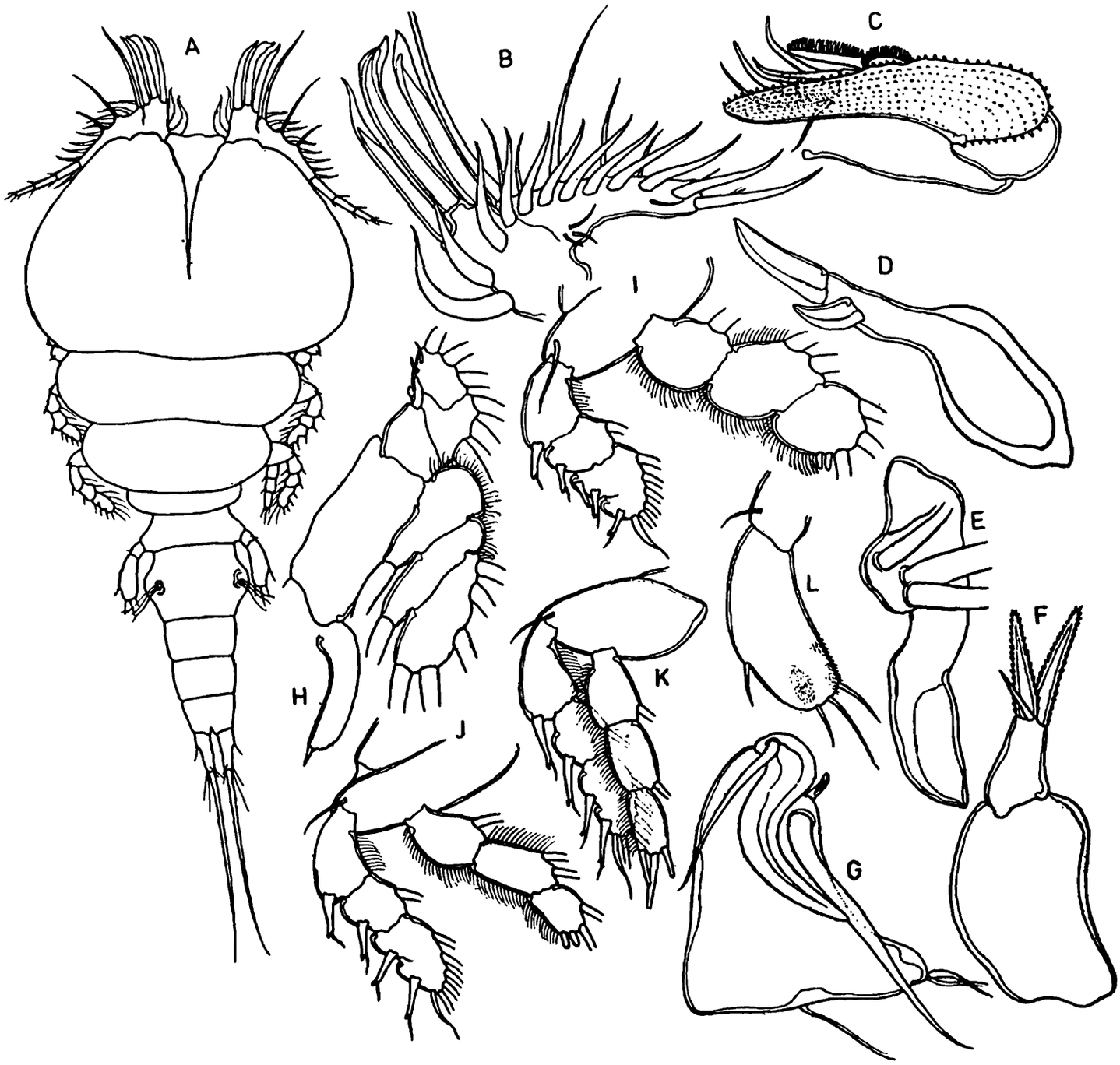


Fig. 14. A-L. *Nothobomolochus multispinosus* (Gnanamuthu) : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxilla ; G. maxilliped ; H-L, legs 1-5.

very long. Egg sacs of average size, narrowing distalwards and reaching the tip of the seta on the caudal rami.

Base of antennule projecting prominently, processes placed on a high pedestal, first process shortest, apically narrow and acute, second process stoutest, apically curved outwards and ending in a

sharp point, third process as stout as second, only slightly curved near the acute apex, naked seta just outside the third process longest, basally stout. Tubercles on third segment of antenna sparsely distributed in longitudinal rows, linguiform extension large, not distinctly demarcated from the segment proper, lamellar process reaching only the middle of the linguiform extension, armed with sharp spines, bulge near its base prominent, there are also three hooks and two setae.

Mandible with comparatively large, subsimilar, but greatly unequal smooth blades. Maxillule with three setae. Paragnath large, curved and smooth. Basal segment of maxilla stout, distal short, blades with serrate borders, longer than distal segment, spine fairly long. Second segment of maxilliped proximally very broad, claw stout, moderately curved, without accessory process.

Rami of first leg only moderately flattened, three-segmented, first exopod segment with a stout spine, second with a spine consisting of a swollen base and slender distal part. Endopod of second leg only slightly broader than exopod, spines arming exopod smooth, with subapical pectinate spinule. Endopod of third leg narrower than exopod, but equal in length. Exopod of fourth leg longer than endopod, with longer claws. Distal segment of fifth leg oblong, slightly curved, distal end perfectly rounded, spines setiform.

*Length.*—2.3 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+II |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 5+III |

*Host.*—*Dussumieria acuta, D. hasseltii*

*Distribution.*—India (Madras, Kerala).

*Remarks.*—The original description as observed by Vervoort is incorrect. This can be easily seen by comparing the setal formula given by Vervoort based on Gnanamuthu's description with the one given here. The fifth leg is exactly as in other species with the usual armature and not as described by Gnanamuthu.

## **Nothobomolochus quadriceros** Pillai
(Fig. 15)

*Nothobomolochus quadriceros* Pillai, 1973, p. 489 figs. 13-24.

*Female.*—Cephalothorax very broad, with bulging rounded postero-lateral and straight posterior borders making it remotely triangular. Rostral plate moderately projecting. Second thoracic segment much narrower than cephalothorax, third, fourth and fifth segments successively narrowing giving the body a characteristic appearance. Genital segment laterally bulging, making it broader than long. Abdomen moderately stout, anal segment conspicuously narrowing. Caudal rami about twice as long as broad. distal inner seta nearly as long as the post-genital part of body. Egg sacs stout, only slightly shorter than body.

Peduncle of antennule proximally projecting. All the three processes apically blunt and nearly of the same width, first longest and second shortest, latter apically recurved. First naked seta placed immediately lateral to the third process, only slightly longer than the process, nearly as stout as the latter and apically drawn out making it appear as if there are four processes in all. Fourth and fifth naked setae long and slender. Distal segment of antenna sparsely spiny, spines in longitudinal rows, linguiform prolongation comparatively long, lamellar process with curved spines, its basal bulge very small, there are five claws and one seta.

Mandible slender, with long distal blade. Subapical blade not observed. Maxillule with one stout, one long and one short seta, paragnath dorsally straight, ventrally bulging and spiny. Maxilla small, with subequal barbed blades, spine not observed. Second segment of maxilliped longer than broad, claw moderately curved, outer border with small concavity followed by a small projection, accessory process absent.

Rami of first leg highly flattened and three-segmented, exopod with two blunt stout spines. Endopod of second leg moderately flattened, claws on exopod smooth. Rami of third leg equal in

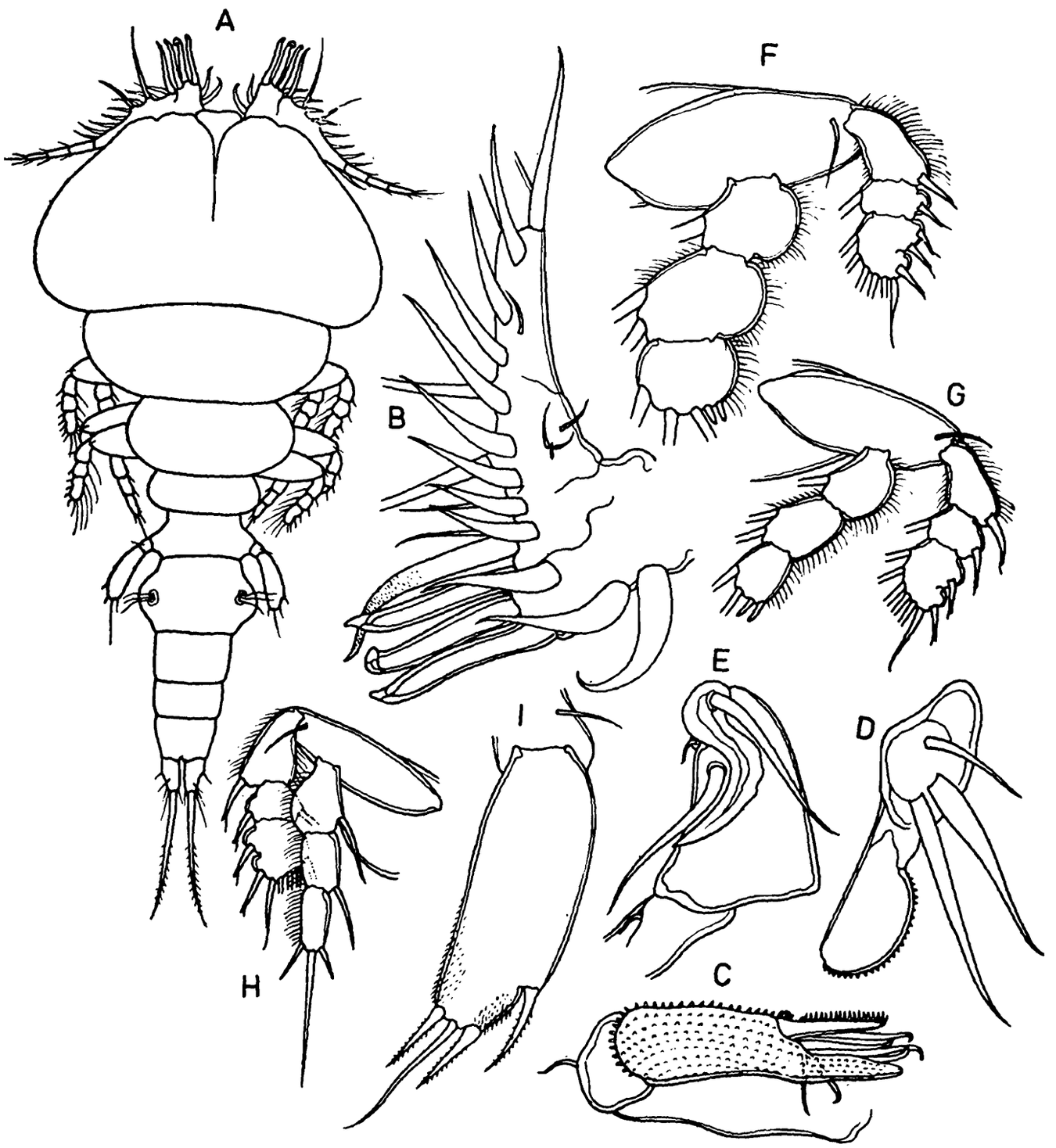


Fig. 15. A-I. *Nothobomolochus quadriceros* Pillai : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxillule ; E, maxilliped ; F-I, legs 2-5.

length and width. Endopod of fourth leg longer and narrower than exopod, apical median spine of third segment long. Second segment of fifth leg long, almost of the same width throughout, spines long and strong, seta slender and long.

*Length.*—1.3 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 1+I, 2+0, 3+I |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Gazza minuta.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta, Reg. No. C2103/2.

*Remarks.*—The outstanding character of this species is the great development of the naked seta outer to the third process of the antennule making it appear that there are in all four processes on the base of the antennule. This character easily distinguishes this species.

## **Nothobomolochus triceros** (Bassett-Smith)
(Fig. 16)

*Bomolochus triceros* Bassett-Smith, 1898a, p. 3, pl. 1, fig. 1 ; 1899, p. 443 ; Gnanamuthu, 1948c, p. 24 ; 1947c, p. 318 ; Sewell, 1949, p. 169 ; Pillai, 1965, p. 39, fig. 15.

*Bomolochus managatuwo* Yamaguti, 1939a, p. 396, pl. 3, figs. 28-29, pl. 4, figs. 30-37.

*Nothobomolochus triceros* Vervoort, 1962, p. 64 ; Pillai, 1967d, p. 1567, fig. 18 : 1969, p. 149, figs. 1-4.

*Female.*—Cephalothorax large, nearly twice as broad as long. Rostral plate projecting but made to appear low by the projecting antennules. Second thoracic segment much narrower than cephalothorax, third still narrower and postero-medially produced over the fourth segment, latter rather small, half as broad as third segment. Fifth segment very short. Genital segment as broad as fifth segment. Abdomen fairly stout. Caudal rami with median distal seta short but stout. Egg sacs of moderate size.

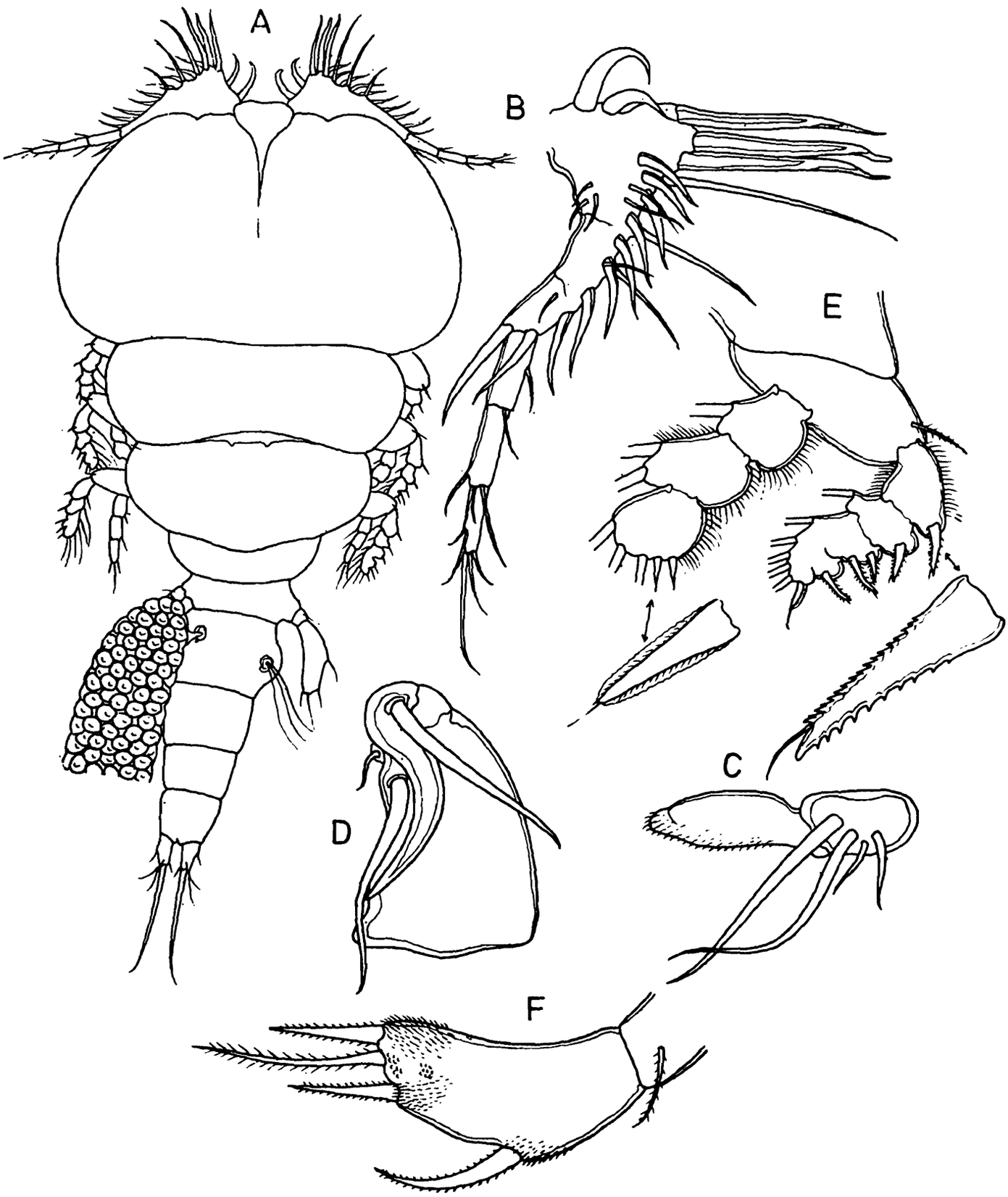


Fig. 16, A-F. *Nothobomolochus triceros* (Bassett-Smith) ; A, female, dorsal view ; B, antennule ; C, maxillule ; D, maxilliped ; E, leg 2 ; F, leg 5.

Processes on antennule long and slender, subequal in length and width, first and third distally drawn out, median distally narrowed but apically blunt. Naked seta just outside the third process longest, overreaching the processes. Distal segment of antenna fully covered with tubercles, not falling into distinct rows but projecting along the borders, linguiform process large, lamellar process and the bulge near its base with short spines, there are seven claws.

Mandible with subequal blades. Maxillule with two large and two short setae. Paragnath irregularly oblong and ventrally spiny. Maxilla with subsimilar dentate blades. Second segment of maxilliped longer than broad, claw evenly curved, without accessory process, large setae subequal in size.

Rami of first leg only moderately flattened, three-segmented. Endopod of second leg nearly as broad as exopod, claws on exopod bilaterally dentate but outer teeth longer, each claw with a subapical setule. Endopod of third leg narrower than exopod, claws similar to those on second leg. Endopod of fourth leg slender, distal segment with two very short spines and a median long spine. Basal segment of fifth leg with a seta, first and third spines on distal segment stout, second shorter, seta long, slender and plumose, there are three patches of spinules.

*Length.*—2.2 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+0, 3+II |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 4+III |

*Host.—Pampus argenteus.*

*Distribution.*—India (Bombay, Kerala).

*Remarks.*—Vervoort observed that this species can be distinguished by the long and slender finger-shaped spines on the antennule. Though this is true the lateral spines are not truly finger-shaped. This species is abundant on *Pampus argenteus.*

## **Nothobomolochus trichiuri** Pillai and Natarajan (Fig. 17)

*Nothobomolochus trichiuri* Pillai and Natarajan, 1977, p. 28, figs. 43-54.

*Female.*—Cephalothorax comparatively very large and clearly overlapping second thoracic segment, its postero-lateral parts with a small declivity. Rostral plate small, with deeply concave border, dorso-median rib short. Second thoracic segment only slightly narrower than cephalothorax, postero-medially strongly concave. Third thoracic segment immersed in second and posteriorly produced, completely covering the fourth segment and a part of the fifth segment. Latter short but broad. Genital segment broader than long. Abdomen comparatively short and narrow, segments subequal in length but successively narrowing. Caudal rami elongated, longer than anal segment, inner distal seta very long, outer very small. Egg sacs long and slender, as long as the body of the animal.

Antennular base only moderately projecting. Setae three to five modified into chitinised processes placed on a moderately large prominence. First process comparatively very small, apically narrowed and curving inwards, its surface rugose. Second process stoutest, strongly chitinised, distal part double curved, apex rounded. Third process nearly as long as second but narrower, its distal part narrow and rugose. Naked seta just outside the third process only slightly longer than the process.

Third segment of antenna longer than first, linguiform extension comparatively large, its surface with blunt prominent tubercles not falling into rows. Lamellar process short but the lobe near its base large, both armed with blunt spines. There are four hooks and two setae, the hook originating near the base of the lamellar process large.

Mandible comparatively small, apical blade large, distally narrow and curving upwards, subapical blade small. Maxillule with two long and two short setae, all comparatively slender. Paragnath ovate, with narrow apex. Maxilla with the usual armature. Second segment of maxilliped elongated, claw stout and strongly curved, accessory process absent.

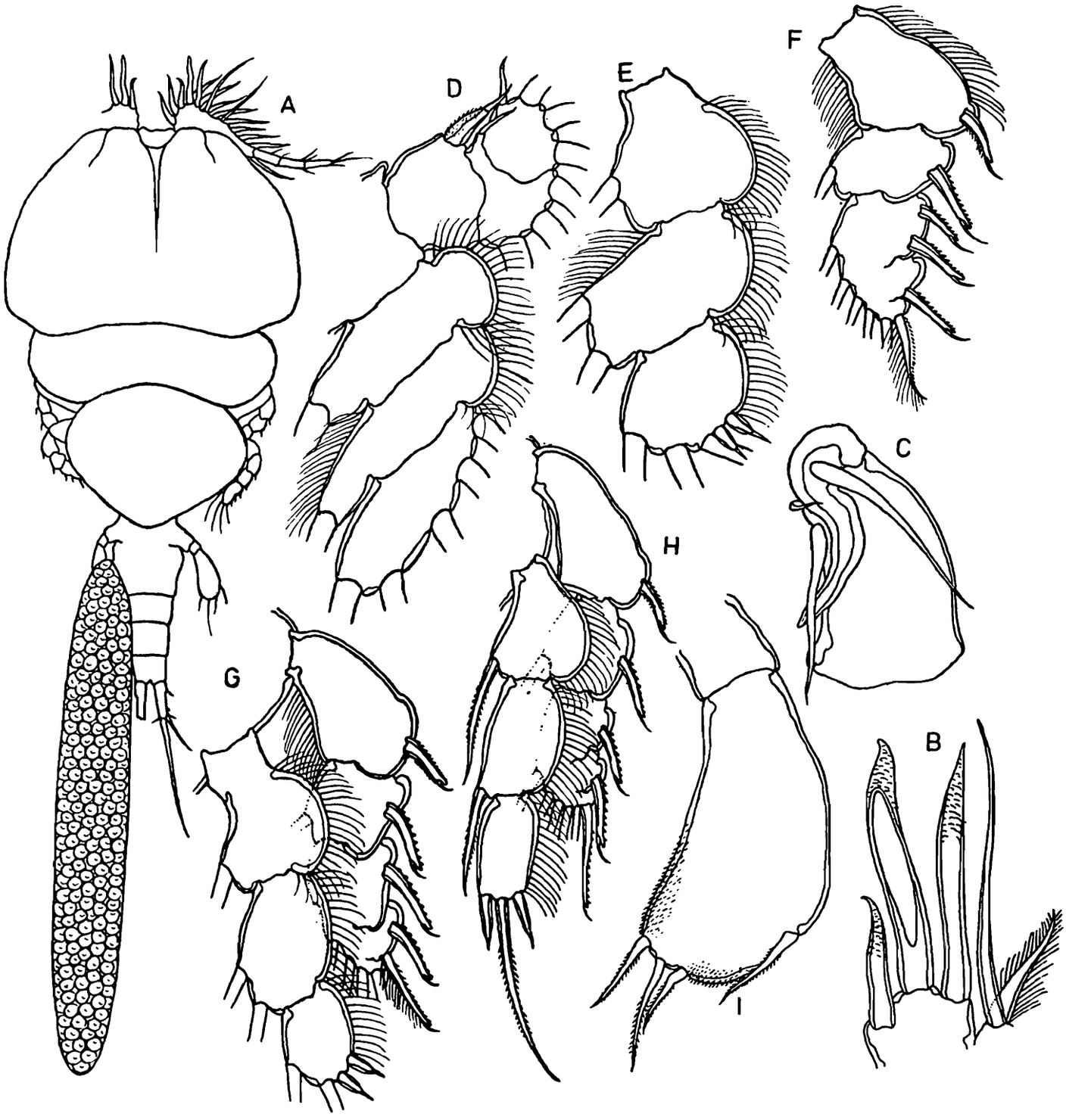


Fig. 17. A-I. *Nothobomolochus trichiuri* Pillai and Natarajan : A, female, dorsal view ; B, antennule ; C, maxilliped ; D, leg 1 ; E, leg 2, endopod ; F, same, exopod ; G, leg 3 ; H, leg 4 ; I, leg 5.

First leg with highly flattened three-jointed rami. First segment of exopod with a large outer process consisting of a short spiny base and slender winged hyaline distal part, second and third segments with a slender setiform spine. Both rami of second leg

flattened but endopod broader, spines on distal segment of endopod with narrow wings and trigger-like apical spinule. Basal segment of exopod hairy on both borders, first claw pectinate on lower border, second to fifth toothed on outer border, sixth winged externally and plumose internally, all with subapical setule. Third leg with the rami equal in width, spines on third endopod segment as in second leg, first spine of exopod bilaterally pectinate and short, others successively increasing in length and armed as in second leg. Exopod of fourth leg similar to that of third, endopod with the usual modification, inner distal spine longer than outer, median spine very long. Basal segment of fifth leg very small, distal segment very large, steadily widening to the base of the outer spine, beyond the spine the segment is rounded, spines slender and pectinate, seta longer than spines, the inner patch of spinules very conspicuous, outer small.

*Length.*—2.0 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 3+I, 3+I |
| Leg 2 | 1+0, 2+0, 3+II | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 5+III |

*Host.—Trichiurus savala.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in National Zoological Collection at Zoological Survey of India, Calcutta, Reg. No. C2104/2

*Remarks.*—In the overall shape of the body and in the nature of the three processes on the base of the antennule this species very closely resembles *N. cypseluri* (Yamaguti) and *N. gibber* (Shiino). But in *N. gibber* the second thoracic segment is narrower than third, quite the reverse in *N. trichiuri.* These two species further differ in the armature of the claws on the exopod of the legs and in the shape of the fifth leg. In *N. cypseluri* the second thoracic segment is only slightly broader than third and much

narrower than cephalothorax, just the opposit in *N. trichiuri*. The claws on the exopod of the legs of *N. cypseluri* are naked and the fifth leg is totally different in shape. By the shape of the fifth leg alone these three species can be easily distinguished.

## Genus **Orbitacolax** Shen

*Orbitacolax* Shen, 1957a, p. 323 ; Vervoort, 1962, p. 79.

*Diagnosis.*—Cephalothorax varying in shape, never much broader than second thoracic segment. Thoracic segments two to four as broad as cephalothorax, with rounded sides and covering basipods of legs or narrower than cephalothorax leaving the basipods exposed. Fourth segment abruptly narrowed. Frontal plate not bent downwards, broader than long, often demarcated by a partition. Abdomen short, half the length of cephalothorax or shorter. Genital segment swollen. Caudal rami with long apical seta.

Peduncle of antennule flattened, setae not modified. Distal segment of antenna with longitudinal rows of spines, three to four hooks and two setae. Maxillule with three setae, one may be very long. Maxilliped with reduced setation, claw with accessory process. First leg highly flattened, exopod segments partially fused, endopod a highly flattened three-jointed lamina. Basipods of legs two to four large, rami three-jointed and spiny, with reduced armature, distal endopod segment of leg four with a long seta. Spines on fifth leg setiform.

Male showing the same type of sexual dimorphism as in *Bomolochus*.

Type-species : *O. uniunguis* Shen.

*Discussion.*—This genus now contains eight species, namely, *O. uniunguis* Shen (1957a), *O. aculeatus* (Pillai, 1962a), *O. leptoscari* (Yamaguti, 1953), *O. dactylopterusi* (Carvalho, 1958), *O. hapalogenyos* (Yamaguti and Yamasu, 1959) *O. analogus* Vervoort (1969), *O. oniscoides* Vervoort (1969) and *O. nudus* Cressey and Collette (1973).

*O. nudus* differs from the others in the absence of an accessory process on the claw of the maxilliped and in the comparatively narrow thoracic segments. This species has to be accommodated elsewhere. Only one species has hitherto been recorded from Indian waters.

## **Orbitacolax aculeatus** (Pillai)
(Fig. 18)

*Bomolochus aculeatus* Pillai, 1962a, p. 610, fig. 1.
*Orbitacolax aculeatus* Pillai, 1967d, p. 1569, fig. 21.

*Female.*—Cephalothorax broader than long, lateral borders rounded, hind border straight. Rostral plate distally rounded, not demarcated by a partition. Second thoracic segment as broad as cephalothorax, third slightly narrower, fourth very narrow, half the width of third and transversely oblong, segments separated by deep lateral gaps. Fifth segment broader than long, but narrower than fourth. Genital segment nearly equal in length and width, with small lateral bulge. Abdomen short, first segment nearly as long as the other two segments combined. Caudal rami longer than broad, with long distal seta. Egg sacs stout, elongate oblong.

Peduncle of antennule with fifteen plumose and four naked setae, distal flagellar segment with two long setae. Inner half of third segment of antenna spiny, linguiform extension large, lamellar process with longer spines, claws four, setae two. Mandible with greatly unequal blades. Maxillule with three setae, one small, paragnath long, constricted in the middle. Distal segment of maxilla produced backwards, distal blades barbed, spine very small. Second segment of maxilliped elongated, with two small inner setae, claw stout, double curved, with small seta and strong accessory process.

Basipod and first two endopod segments of first leg tubercular, endopod highly flattened. Rami of legs two to four narrow, three-jointed, claws on exopod setiform except the apical which is strong and externally dentate. Exopod segments spiny and endopod segments hairy. Third leg similar to second but the rami slightly broader. Rami of fourth leg slightly broader than those of third,

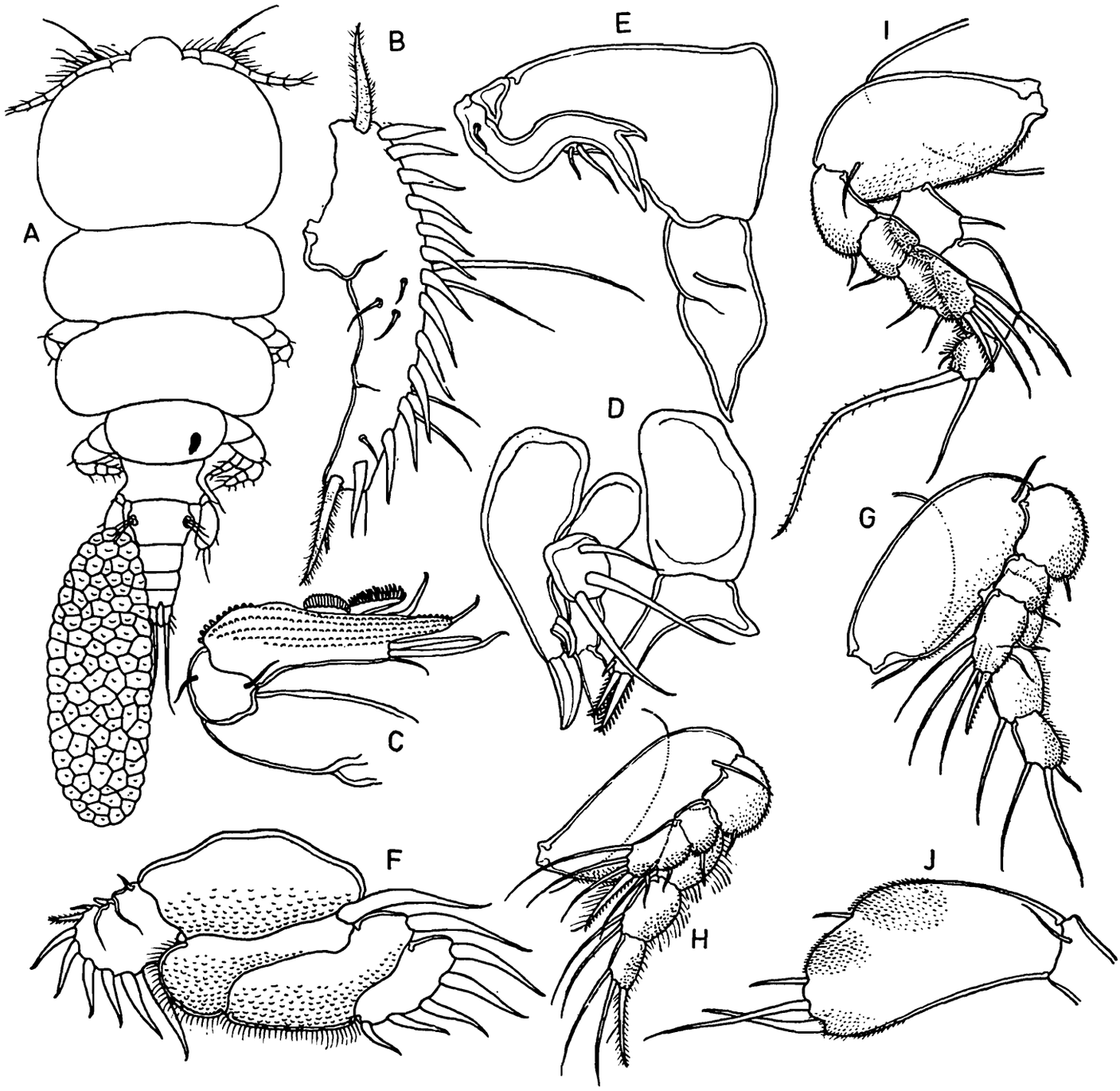


Fig. 18. A-J. *Orbitacolax aculeatus* (Pillai) : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible, maxillule and maxilla ; E, maxilliped ; F, leg 1 ; G, leg 3 ; H, leg 2 ; I, leg 4 ; J, leg 5.

third endopod segment small, with very long distal median seta. Basal segment of fifth leg short, distal broad, first spine very small, second of medium length, third long and stout, seta long and slender, there are three large patches of spinules.

*Length.*—1.2 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 6+IV |
| Leg 2 | 1+0, 2+0, 3 | 0+I, 0+I, 3+III |
| Leg 3 | 1+0, 1+0, 2+I | 0+I, 0+I, 3+III |
| Leg 4 | 1+0, 1+0, 2+I | 0+I, 0+I, 3+III |

*Host.—Rastrelliger kanagurta.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta, Reg. No. C2105/2

*Remarks.—O. aculeatus* resembles *O. leptoscari, O. dactylopterusi, O. hapalogenyos* and *O. analogus* in the presence of deep incisions between the thoracic segments. But the shape of the cephalothorax easily distinguishes *O. aculeatus.*

## Genus **Pseudorbitacolax** Pillai

*Pseudorbitacolax* Pillai, 1971, p. 13.

*Diagnosis.*—Cephalothorax comparatively very large, its hind border nearly transverse. Frontal plate broad, with median concavity. Thoracic segments much narrower than cephalothorax, successively narrowing. Genital segment anteriorly swollen, narrow behind. Abdomen short, narrowing. Caudal rami with six setae. Egg sacs long and slender.

Peduncle of antennule flattened, with fifteen plumose setae. Third segment of antenna sparsely spiny, with five claws and one seta. Maxillule with three small setae. Second segment of maxilliped elongated, with two setae, claw without accessory process. Rami of first leg flattened, segmentation indistinct. Rami of legs two to four three-segmented, with reduced setation, third endopod segment of leg four with long seta, apical claw of third exopod segment barbed. Fifth leg with setiform spines.

Male unknown.

Type-species : *P. varunae* (Bennet).

*Discussion.*—This genus differs from *Orbitacolax* in the absence of an accessory process on the claw of the maxilliped and in the elongated second segment of the maxilliped.

Cressey and Boyle described *O. nudus* which to a large extent resembles *Pseudorbitacolax*. Its maxilliped is quite unlike that of *Orbitacolax*. This species could therefore be appropriately placed in *Pseudorbitacolax*.

**Pseudorbitacolax varunae** (Bennet)
(Figs. 19-20)

*Bomolochus varunae* Bennet, 1966, p. 295, figs. 1-3.
*Pseudorbitacolax varunae* Pillai, 1971, p. 14, figs. 1-2.

*Female.*—Cephalothorax comparatively large, its anterior border four-lobed, antero-median concavity shallow. Rostral plate transversely rectangular and antero-medially concave. Antero-dorsal part with four chitinised ridges similar to those found in *Orbitacolax nudus*. Thoracic segments two and three transversely rectangular, postero-lateral parts produced into small lobes. Fourth segment nearly circular, distally constricted. Fifth segment broader than long, remotely oblong and considerably overlapped by the fourth segment. Genital segment as broad as fifth thoracic segment, antero-laterally bulged and strongly narrowing. Abdomen short and narrow. Caudal rami with five short setae and a distal median longer seta, latter basally broad and naked and distally narrow and pectinate. Egg sacs long and slender.

Peduncle of antennule with fifteen plumose setae, third and sixth long, flagellum with long apical seta. Third segment of antenna with spines on lower half, there is a grooved blunt process, a linguiform extension, five hooks and one seta.

Distal blades of mandible slender and similar. Maxillule with three small setae, paragnath linguiform. Maxilla with large basal

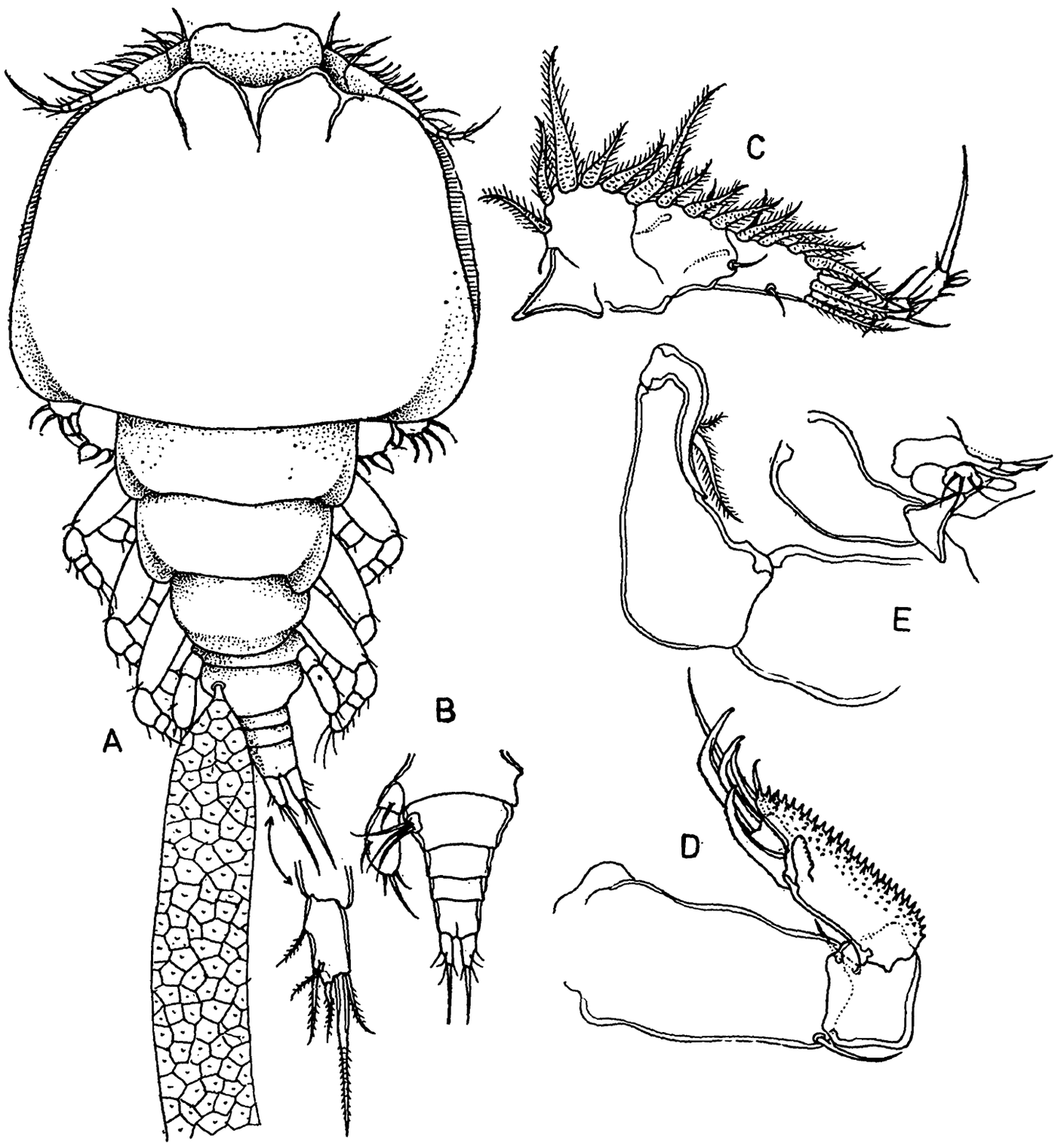


Fig. 19. A-E. *Pseudorbitacolax varunae* (Bennet) : A, female, dorsal, view ; B, hind end of body ; C, antennule ; D, antenna , E, mandible, maxillule, maxilla and maxilliped.

segment, distal segment proximally produced backwards into a conical process, blades long and slender. Second segment of maxilliped elongated, with two inner distal setae, one long and the

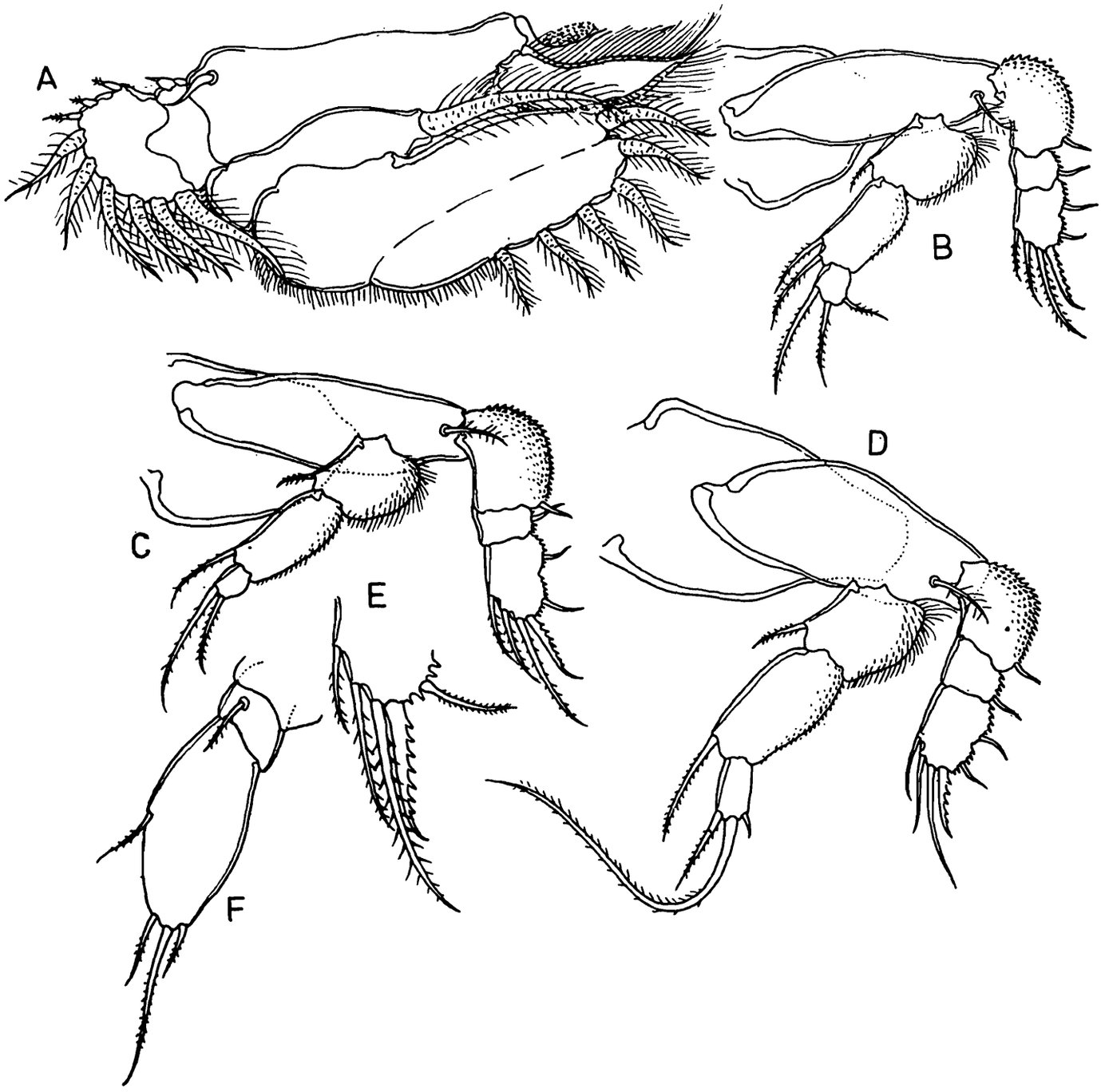


Fig. 20. A-F. *Pseudorbitacolax varunae* (Bennet) (contd.) ; A-D, legs 1-4 ; E, leg 4, tip of exopod ; F, leg 5.

other short, claw basally produced forwards and only slightly curved, accessory process absent.

Rami of first leg flattened, exopod two-jointed, endopod highly flattened and indistinctly three-segmented. Second leg comparatively small, rami three-segmented, outer part of exopod segments spiny, that of endopod segments with stiff hairs. Third leg similar

to second but its exopod broader. Fourth leg longer than third, endopod broader apical median seta of third segment longer than the ramus. Spines on the exopod of all the legs, except the last spine, setiform, latter stout and barbed. Basal segment of fifth leg short, with a seta, distal segment distally narrowed, with a long apical seta, spines setiform and pectinate.

*Length.*—1.6 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | 0+I, 6+III |
| Leg 2 | 1+0, 2+0, 3 | 0+I, 0+I, 3+III |
| Leg 3 | 1+0, 1+0, 2 | 0+I, 0+I, 3+III |
| Leg 4 | 1+0, 1+0, 3 | 0+I, 0+I, 3+III |

*Host.—Anodontostoma chacunda.*

*Distribution.*—INDIA (Cochin to Karwar).

*Holotype.*—Female in the Central Marine Fisheries Research Institute.

## Genus **Pumiliopes** Shen

*Pumiliopes* Shen, 1957a, p. 322 ; Vervoort, 1962, p. 88.

*Diagnosis.*—Cephalothorax large and flat, thoracic segments much narrower than cephalothorax, successively narrowing and gradually merging into the abdomen. Rostrum set off by lateral incisions. Third thoracic segment covering part of fourth segment. Fifth segment narrow. Abdomen short and slender. Caudal rami with apical seta thick. Peduncle of antennule thick, with fourteen plumose setae. Third segment of antenna with very few large denticles, a stout hook, three to four small hooks and one to two setae. Mandible as in *Bomolochus*. Maxillule with three small setae, paragnath present. Distal segment of maxilla basally produced. Second segment of maxilliped with two setae, claw without accessory process. First leg with two-jointed highly flattened rami. Legs two to four with two-jointed rami. Endopod of fourth leg three-jointed.

Male unknown.

Type-species *P. opisthopteri* Shen.

*Discussion.*—This genus contains four species, namely, *P. opisthopteri* Shen (1957a), *P. capitulus* Cressey and Boyle (1973), *P. squamosus* Cressey and Boyle (1973) and *P. jonesi* (Bennet, 1967). The last alone has been recorded from the present locality.

**Pumiliopes jonesi** (Bennet)

*Bomolochus jonesi* Bennet, 1967, p. 132, figs. 1-2.

*Female.*—Cephalothorax comparatively large, broader than long, frontal plate much broader than long, with median concavity. Second thoracic segment much narrower than cephalothorax, segments two to five successively narrowing, not covering the basipods of legs. Genital segment bulging laterally. Abdomen short, three-jointed, segments subequal in length but successively narrowing. Caudal rami as long as anal segment, both the anal segment and caudal rami dorsally spinulose. Egg sacs elliptical, sometimes elongated.

Antennule six-segmented, basal two segments flattened. Antenna rather small, three-jointed, first segment longest, third ventrally toothed and with five blunt claws, one of them stout. Mandible with two dissimilar claws. Maxillule without setae? Maxilla with elongated subsimilar barbed blades. Maxilliped elongated, claw without accessory process and setae.

First leg highly flattened, rami two-jointed. Basipod of legs two to four two-jointed and enlarged, exopod two-jointed, basal segment externally spiny, with one small claw, distal segment with one apical stout smooth claw. Endopod of legs two and three two-jointed, externally hairy, basal segment with one inner distal spine, distal segment of second leg with five and of third with three spines. Endopod of fourth leg three-jointed, first and second segments with one and third with three spines, apical spine of third segment large and strongly barbed. Distal segment of fifth leg with a large patch of spinules, an indistinct partition and three setae, outer seta very small.

Length not given.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 4 | 0+I, 7 |
| Leg 2 | I+0, V | 0+I, I |
| Leg 3 | I+0, III | 0+I, I |
| Leg 4 | I+0, I+0, III | 0+I, I |

*Host.—Rastrelliger kanagurta.*

*Distribution.*—India (Calicut).

*Holotype*—in the Central Marine Fisheries Research Institute.

*Remarks.*—In the overall shape of the body this species closely resembles *Pseudorbitacolax varunae* (Bennet) but the latter has distinctly three-jointed rami on legs two to four. In the shape, segmentation and armature of the legs this species shows exact similarity to species of *Pumiliopes*.

The description of this species by Bennet is very unsatisfactory and the illustrations are bad. His description of the first leg, maxilla, maxilliped and fifth leg is certainly wrong. I could not secure a specimen for study.

## Genus **Pumiliopsis** Pillai

*Pumiliopsis* Pillai, 1967a, p. 249.

*Diagnosis.*—Cephalothorax large, rest of body narrow and slender. Rostral plate prominent, with a pair of chitinised plates originating near its base and extending on to the cephalothorax. Thoracic segments two to four successively narrowing, not covering the basipods of legs. Genital segment enlarged. Abdomen indistinctly segmented.

Distal flagellar segment of the antennule with long apical seta. Third segment of antenna with linguiform extension, lamellar process and claws. Maxillule with three setae, one very long.

Second segment of maxilliped elongated, setae small, claw stout, without accessory process. First leg with flattened two-jointed rami. Exopod of legs two to four short, two-segmented, with spiny surface, endopod of legs two and three two-jointed, of leg four three-jointed.

Cephalothorax of male pyriform, rostral plate large. Thoracic segments two to four progressively narrowing. Fifth and genital segments broader than fourth segment. Abdomen three-jointed. Caudal rami with very long apical seta. Antennule with long slender setae. Maxilliped chelate. Rami of legs one to four two-to three-segmented. Distal segment of fifth leg slender, with two distal setae.

Type-species : *P. sardinellae* (Bennet).

*Discussion.*—This genus contains three species, namely, *P. sardinellae* (Bennet, 1964), *P. plautus* Cressey and Boyle (1973) and *P. emarginatus* Cressey and Boyle (1973). The first two have been recorded from Indian waters.

*Pumiliopsis* differs from *Pumiliopes* in the presence of a conical rostrum, seven-segmented antennule, typical bomolochid antenna, maxillule with one of the setae elongated and in the normal second segment of the maxilla. The apical claw of the exopods of legs is barbed and not smooth as in *Pumiliopes*.

*Key to species of* **Pumiliopsis**

1. Fifth leg small, typically bomolochid. .*sardinellae* (Bennet)

— Fifth leg large, highly flattened and modified .*plautus* Cressey and Boyle

## **Pumiliopsis sardinellae** (Bennet)
(Figs. 21-22)

*Bomolochus sardinellae* Bennet, 1964, p. 84, figs. 1-2.
*Pumiliopsis sardinellae* Pillai, 1967a, p. 250, figs. 1-29; 1967d, p. 1569, fig. 22.

*Female.*—Cephalothorax large, swollen, with a pair of ribs just below the insertion of the rostral plate. Second thoracic segment

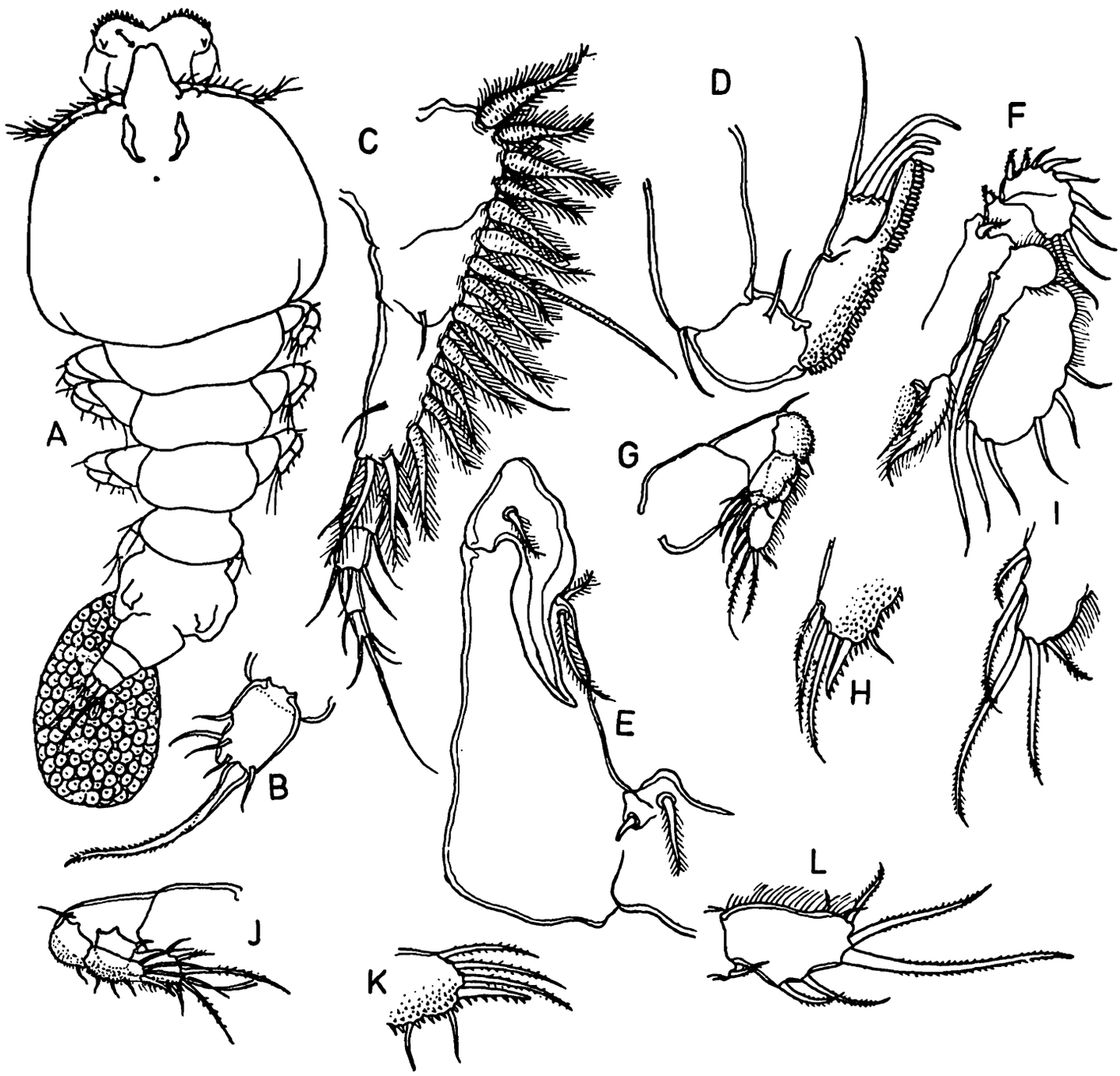


Fig. 21. A-L. *Pumiliopsis sardinellae* (Bennet) : A, female, dorsal view ; B, caudal ramus ; C, antennule , D, antenna ; E, maxilliped ; F, leg 1 ; G, leg 2 ; H, same, exopod ; I, same, endopod ; J, leg 3 ; K, same exopod ; L, same, endopod.

half as broad as cephalothorax, its lateral borders rounded, third and fourth segments transversely oblong, fifth segment with short anterior neck-like constriction. Thoracic segments two to four successively narrowing. Genital segment abruptly enlarged, with short anterior neck, postero-laterally produced. Abdomen short,

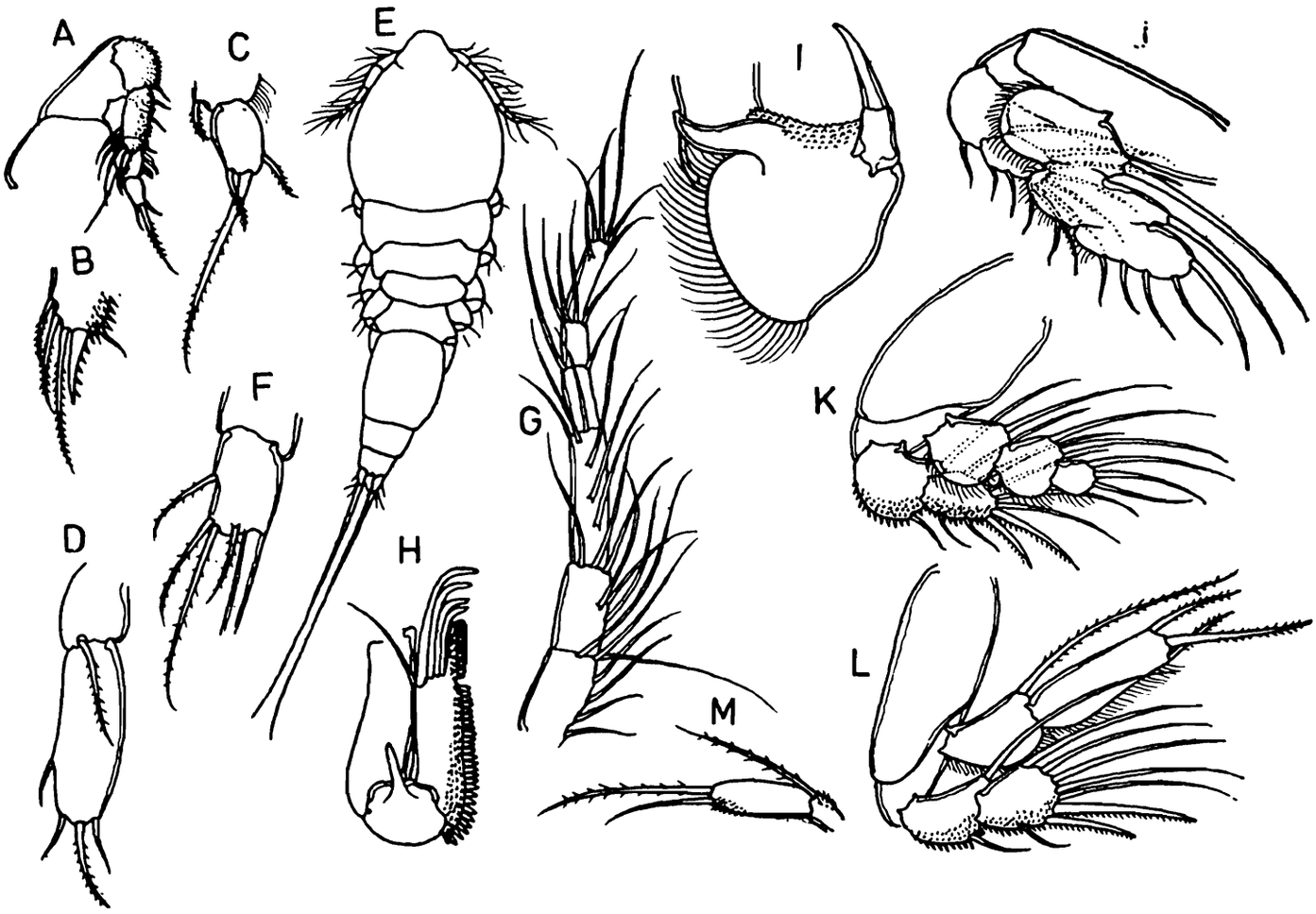


Fig. 22. A-D. *Pumiliopsis sardinellae* (Bennet) (contd.), female : A, leg 4 ; B, same, exopod ; C, same, endopod ; D, leg 5; E-M, male ; E, male, dorsal view ; F, caudal ramus ; G, antennule ; H, antenna ; I, maxilliped ; J, leg 1, J, leg 2 ; L, leg 4 ; M, leg 5.

very narrow, three-segmented, first segment as long as the others combined. Caudal rami longer than broad, distal inner seta stout, not very long. Egg sacs oblong, short and stout.

Peduncle of antennule flattened, with fifteen plumose setae, flagellum with long apical seta. Third segment of antenna with its lower part spiny, marginal spines longer, lamellar process, four claws and one seta present. Apical blade of mandible large, with broad wing, subapical blade small and winged. Maxillule with two short setae and a long pectinate seta. Maxilla with subsimilar strongly barbed blades. Second segment of maxilliped elongated, with proximal inner spine and two distal inner setae, base of claw produced, carrying a seta, distal part only slightly curved, accessory process absent.

Rami of first leg highly flattened, exopod indistinctly three-segmented, endopod two-segmented. Rami of legs two to four except the endopod of leg four two-segmented, latter three-segmented. Exopod segments prominently spiny, claws setiform, apical claw stout and toothed. Endopod segments hairy. Fifth leg with three naked setiform spines and one seta.

*Length.*—2.6 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 5 | 0+I, 7+II |
| Leg 2 | 1+0, 5+0 | 0+I, 3+IV |
| Leg 3 | 1+0, 5+0 | 0+I, 3+IV |
| Leg 4 | 1+0, 1+0, III | 0+I, 3+IV |

*Male.*—Cephalothorax pyriform, with large rostrum. Thoracic segments two to four successively narrowing, postero-laterally overlapping. Fourth segment transversely elliptic, fifth triangular, broader than fourth. Genital segment longer than broad, barrel-shaped. Abdomen two-segmented. Caudal rami with very long apical seta.

Antennule slender and six-jointed, setae long and naked. Second segment of antenna with a blunt spine, third segment as in female. Second segment of maxilliped with prominent thumb-like claw, inner surface spiny, outer hairy, third segment slender, with a partition. Exopod of first leg two-jointed, endopod flattened and three-jointed. Legs two and three with spiny two jointed exopod and three-jointed endopod. Leg four with two-jointed rami, distal endopod segment long. Distal segment of fifth leg slender, with two setae and a patch of spinules.

*Length.*—1.0 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+I, 5 | 1+I, 5+IV |
| Leg 2 | 1+0, 2+0, 3 | 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 3 | 1+I, 5+IV |
| Leg 4 | 1+0, III | 1+I, 5+III |

*Host.*—*Sardinella albella.*

*Distribution.*—India (Mandapam).

Types in the Central Marine Fisheries Research Institute.

*Remarks.*—*P. sardinellae* closely resembles *P. emarginatus* Cressey and Boyle but in the latter the abdominal segments are fused and comparatively short.

**Pumiliopsis plautus** Cressey and Boyle
(Fig. 23)

*Pumiliopsis plautus* Cressey and Boyle, 1973, p. 3, figs. 25-38.
*Pumiliopsis spathepedes*, Bennet, 1974, p. 156, figs. 1-2.

*Female.*—Cephalothorax comparatively large, transversely ovate, frontal plate projecting. Thoracic segments two to five very much narrower than cephalothorax, successively but gradually narrowing, the septa between the segments rather indistinct. Genital segment swollen, nearly as long as broad. Abdomen very slender and short, apparently four-segmented. Caudal rami ovate, longer than broad, with apical seta as long as the ramus. Egg sacs were absent.

Basal segments of antennule fused and flattened, with fifteen plumose setae and three naked setae, second naked seta long. Basal segment of antenna stout, third segment ventrally spiny and distally produced into a stout claw and two processes with ventral row of blunt spines, fourth segment apparent, with one seta and three claws. Mandible elongated, with greatly unequal blades. Maxillule with three setae, middle seta very long and pectinate, paragnath distally narrowed. Maxilla with two pectinate blades and a slender spine. Maxilliped elongated, basal segment with one seta, second with two setae, claw proximally produced forwards, with a small seta and an accessory process.

First leg flattened, both rami two-jointed, endopod highly flattened. Rami of legs two and three two-jointed, exopod externally spiny and endopod hairy. Outer claws on exopod weak and pectinate, distal claw strong and barbed, setae long and pectinate. Exopod of fourth leg similar to that of third, endopod three-jointed,

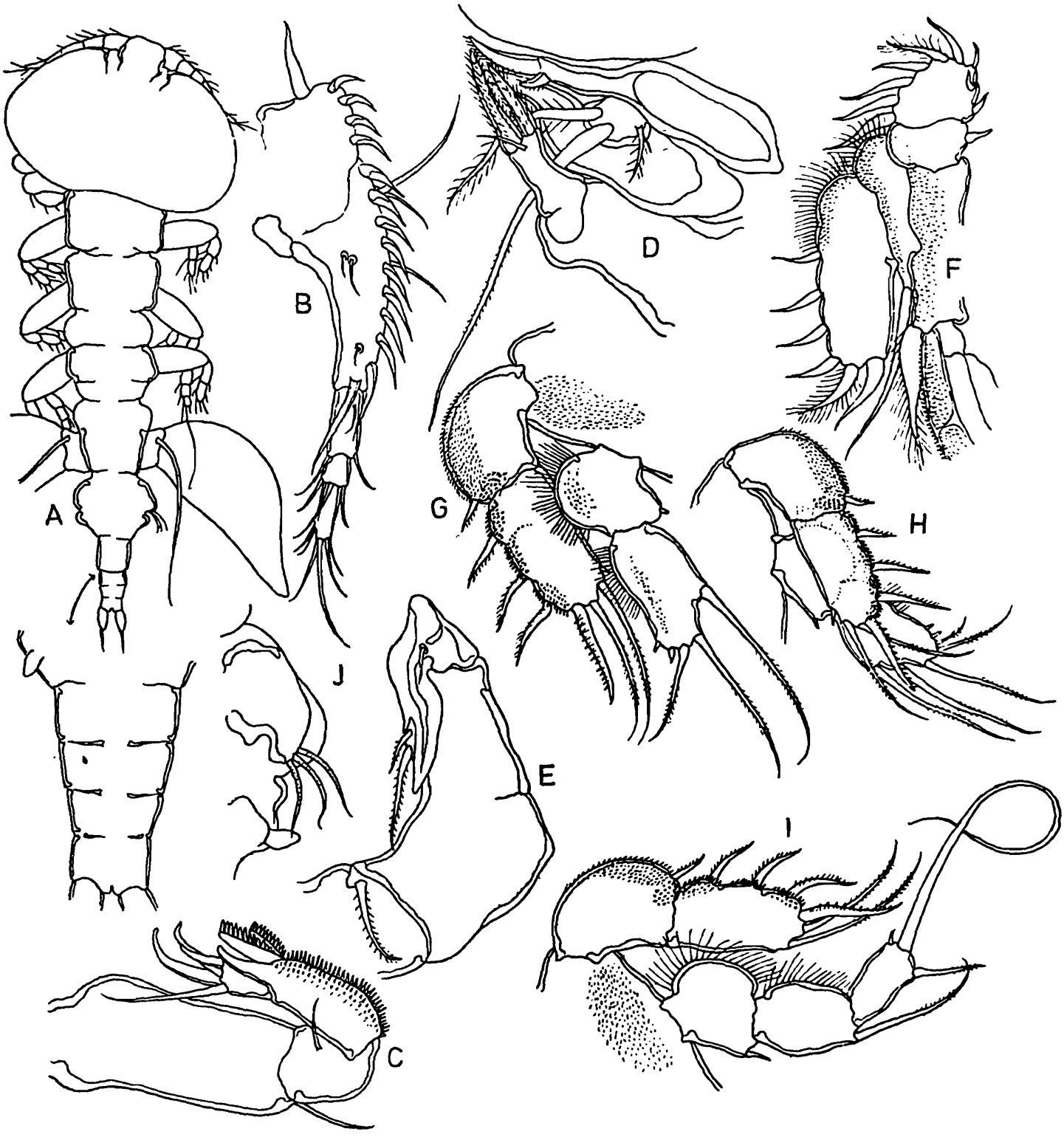


Fig. 23. A-J. *Pumiliopsis plautus* Cressey and Boyle : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible, maxillule and maxilla ; E, maxilliped ; F, leg 1 ; G, leg 3 ; H, leg 2 ; I, leg 4 ; J, leg 6.

apical seta of third segment very long. Seta on basal segment of fifth leg very long, distal segment a large flattened lamina with very small marginal setae.

*Length.*—2.9 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 6 | 0+I, 6+III |
| Leg 2 | 1+0, 5+II | 0+I, 2+IV |
| Leg 3 | 1+0, 3+II | 0+I, 3+IV |
| Leg 4 | 1+0, 1+0, 2+I | 0+I, 2+IV |

*Host.—Sardinella sirm, S. leiogaster.*

*Distribution.*—Phillippines, India (Kerala).

Type in the U.S. National Museum.

*Remarks.*—The present description is based on a single specimen kindly gifted by Mr. Sam Bennet. Unfortunately it was slightly damaged during transit. Certain minor differences from the description published by Cressey and Boyle were observed. These can be understood by comparing the figures.

## Family TAENIACANTHIDAE

*Diagnosis.*—Cephalon partially or completely fused with first thoracic segment, forming a cephalothorax not much broader than the succeeding thoracic segment. Rostral plate not bent downwards, apically blunt. Second thoracic segment normal or drawn out into a long neck (*Scolecicara*), third and fourth segments free or fused. Fifth segment free, not much broader than genital segment, latter not enlarged, merging into the abdomen. Abdomen short or long, three-or four-jointed. Caudal rami with short setae.

Antennule four-to seven-jointed, moderately flattened and not clearly demarcated into peduncle and flagellum. Maxillary hook present or not. Antenna three-jointed, third segment ventrally spiny, with one or two spiny processes, hooks and setae. Mandible, maxillule and maxilla generally as in Bomolochidae. Maxilliped behind the maxillae, its third segment variously armed, lying alongside the second segment or absent. First leg with moderately broad rami, one-to three-segmented, rami of legs two to four three segmented. Fifth and sixth legs as in Bomolochidae. Egg sacs long and slender, eggs multiseriate.

Male showing dimorphism mainly in the maxillipeds.

*Discussion.*—Under Taeniacanthidae Yamaguti included *Taeniacanthus* Sumpf (1871), *Anchistrotos* Brian (1906), *Irodes* Wilson (1911a), *Parataeniacanthus* Yamaguti (1939a), *Phagus* Wilson (1911a), *Pseudotaeniacanthus* Yamaguti and Yamasu (1959) and *Taeniacanthodes* Wilson (1935a). Pillai (1963e) added *Metataeniacanthus*, Cressey (1969) Taeniastrotos and Ho (1969) *Scolecicara*. *Metataeniacanthus*, *Pseudotaeniacanthus*, *Taeniacanthodes* and *Scolecicara* possess well defined characters and are easy to recognise. But *Anchistrotos*, *Parataeniacanthus* and *Irodes* are founded on inadequate grounds. Species of *Taeniacanthus* differ so much from one another that the characters supposed to distinguish *Anchistrotos* and *Parataeniacanthus* fall within the range of variation shown by *Taeniacanthus*. Ho showed that *Irodes* has to be discarded. The same treatment appears to be necessary for *Anchistrotos* and *Parataeniacanthus*. A revision of the family as done by Vervoort for Bomolochidae is urgently needed.

*Key to genera of* TAENIACANTHIDAE

1. Maxillary hooks lateral and separate .2

— Maxillary hooks median, fused .**Pseudotaeniacanthus** Yamaguti and Yamasu

2. Head fully fused with first thoracic segment, abdomen moderately long .3

— Head incompletely fused with first thoracic segment, abdomen very long .**Parataeniacanthus** Yamaguti

3. Cephalothorax only moderately broader than thoracic segments .4

— Cephalothorax much broader than thoracic segments .**Anchistrotos** Brian

4. Abdomen moderately long and slender **Taeniacanthus** Sumpf

— Abdomen as long as rest of body, swollen .**Metataeniacanthus** Pillai

## Genus **Taeniacanthus** Sumpf

*Taeniacanthus* Sumpf, 1871, p. 7.
*Eucanthus* Claus, 1864, p. 378.
*Irodes* Wilson, 1911a, p. 390.

*Diagnosis.*—General shape of body varying. Cephalon fused with first thoracic segment forming a cephalothorax longer than or subequal to second thoracic segment. Thoracic segments two to five successively narrowing or two to four subequal to cephalothorax in size. Genital segment only slightly enlarged. Abdomen three or four-segmented, long and slender, rarely short.

Antennule four-to seven-segmented, basal segments slightly flattened and partially fused. Maxillary hook present. Mandible, maxillule and maxilla as in the family diagnosis. Maxilliped three segmented, third segment a variously armed claw, occasionally absent. First leg flattened, rami one-to three-segmented. Legs two to four with three-segmented rami, armed with different types of claws.

Male smaller than female. Maxilliped large and subchelate.

Parasites of elasmobranchs and teleosts.

Type species *T carchariae* Sumpf.

*Discussion.*—This genus now includes a large number of species which differ so much in the shape of the body and the armature of the maxilliped and legs that specific identification is comparatively easy. But the generic characters are so vague that one often finds difficulty in deciding whether a particular species really belongs to this genus.

*Key to species of* **Taeniacanthus**

1. Thoracic segments two to four subequal to cephalothorax in size, abdomen short ..... *.lagocephali* Pearse

— Thoracic segments two to four smaller than cephalothorax, abdomen long ..... .2

2. Third segment of maxilliped present ..... *.dentatus* Sebastian

— Third segment of maxilliped absent ..... .3

3. Third endopod segment of leg four elongated, claws on exopod cylindrical and winged .*longicaudus* Pillai

— Third endopod segment of leg four not elongated, claws on exopod narrowing, smooth and apically bifid .*indicus* Pillai

— Third endopod segment of leg four very short, claws on exopod narrowing and barbed .*narcini* Pillai

## **Taeniacanthus dentatus** Sebastian

*Taeniacanthus dentatus* Sebastian, 1964, p. 94, figs. 1-10 ; Pillai, 1967d, p. 1560, fig. 4.

*Female*.—Cephalothorax comparatively large, nearly circular in outline. Thoracic segments two to four successively decreasing in width, equal in length and overlapping. Fifth segment narrow, equal to genital segment in size. Abdomen long, four-segmented, anal segment longest. Caudal rami long and slender, apical seta long. Egg sacs long and slender.

Antennule six-jointed, peduncular segments moderately flattened. Maxillary hook slightly curved, with broad base. Third segment of antenna with lower part spiny, there are four claws and two setae. Blades of mandible subsimilar. Maxillule w th one small and two long setae. Paragnath broad, distally narrowed. Blades of maxilla subsimilar and spiny, spine sharp. Maxilliped irregular in shape, second segment with two inner proximal setae, third segment bent backwards and distally inwards, its ventral border cut into five to six blunt processes.

First leg moderately flattened, with distinctly three-segmented rami, endopod broader. Endopod of second leg slightly broader than exopod, its third segment with three blunt feebly winged spines. Third leg similar to second but the third endopod segment with only two setae, third claw slightly longer. Third endopod segment of fourth leg with two short claws and a long naked spine-like seta. Basal segment of fifth leg with a short seta, second segment with three blunt spines and one seta, inner distal part spiny.

*Length.*—2.5 mm

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 6 | 0+0, 1+0, 8 |
| Leg 2 | 1+0, 2+0, 3+III | 0+1, 1+1, 4+III |
| Leg 3 | 1+0, 2+0, 2+III | 0+1, 1+1, 4+III |
| Leg 4 | 1+0, 1+0, III | 0+1, 1+1, 4+III |

*Host.*—*Bembrops caudimaculata.*

*Distribution.*—India (Kerala).

*Remarks.*—The shape and armature of the third segment of the maxilliped and the armature of the third endopod segment of legs two to four easily distinguish this species.

**Taeniacanthus indicus** Pillai
(Fig. 24)

*Taeniacanthus indicus* Pillai, 1963e, p. 112, fig. 1 ; 1967d, p. 1559, fig. 1.

*Female.*—Cephalothorax comparatively large, postero-laterally angular and antero-medially produced, making it triangular, a faint transverse groove indicates the line of fusion of the first thoracic segment. Thoracic segments two to four successively narrowing. Fifth segment anteriorly constricted and produced at the base of the legs. Genital segment large, proximally bulging. Abdomen four-jointed, long and narrowing. Caudal rami twice as long as broad, apical inner seta twice as long as outer.

Distal segment of antenna ventrally spiny, with linguiform extension, three stout claws and two setae. Blades of mandible subsimilar and spiny. Maxillule with one small and two long setae. Claws of maxilla greatly unequal. Second segment of maxilliped irregular in shape, with small inner proximal projection carrying two setae, third segment absent.

Rami of first leg three-jointed, endopod broader. Rami of legs two to four three-segmented. Endopod of second leg slightly longer and broader than exopod, second segment with one inner tooth,

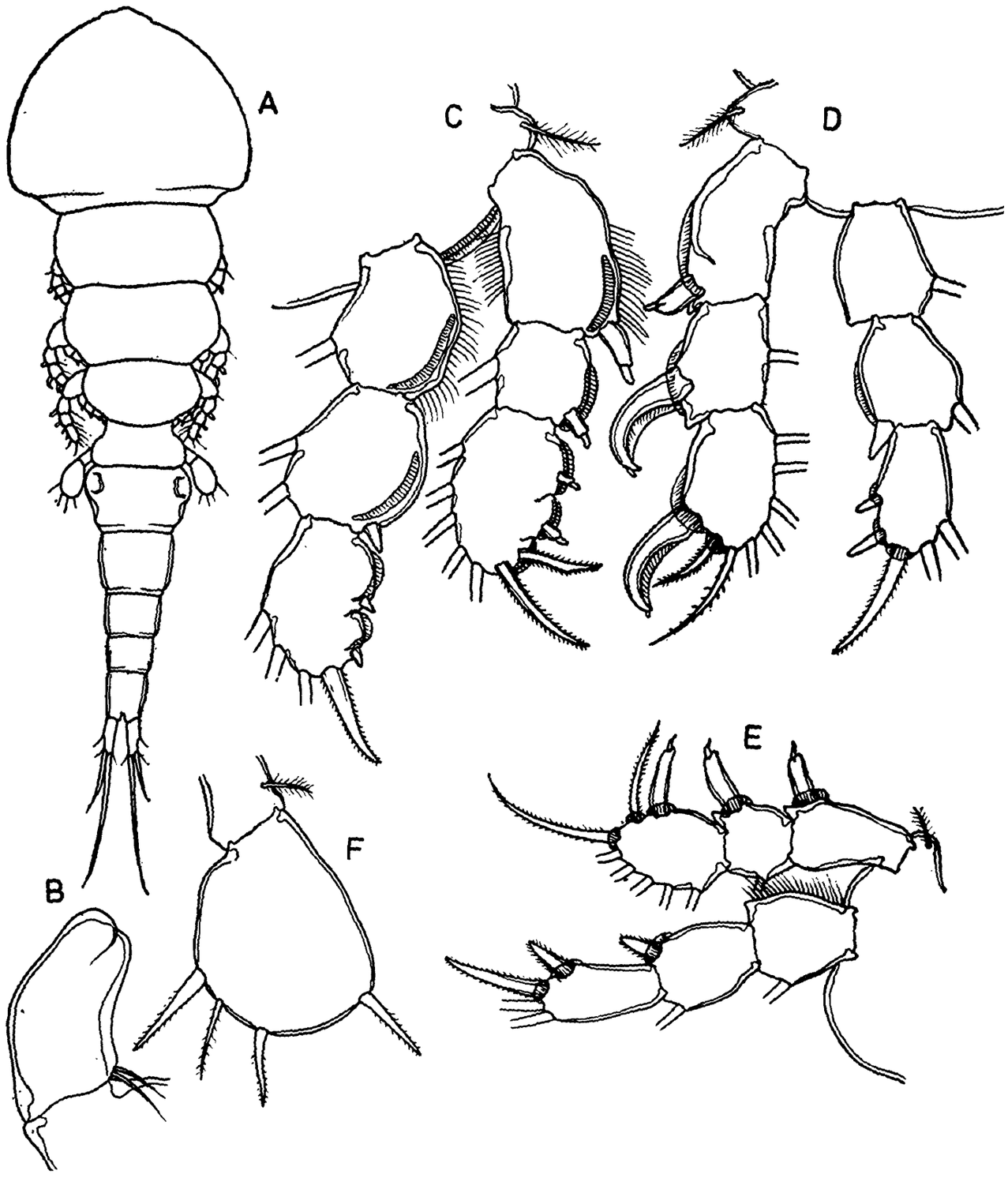


Fig. 24. A-F *Taeniacanthus indicus* Pillai : A, female, dorsal view ; B, maxilliped ; C-F, legs 2-5.

third with two teeth and a long barbed spine. First and second exopod segments with a short tooth consisting of a broad base and a short blunt narrow process, third segment with two similar teeth

and two long spines. All segments with spiny frill on outer border. Exopod of third leg much stouter than endopod, first segment with short stout tooth, second and third with a large sickle-shaped flanged claw, third with two slender spines, second segment of endopod with outer tooth, third with two teeth and a long spine. Fourth leg comparatively small, each exopod segment with one tooth, third with two additional spines, second endopod segment with one tooth, third with a tooth and a long spine. Distal segment of fifth leg highly flattened and ovate, with three setiform spines and a seta.

*Length.*—2.4 mm

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 8 | 0+0, 1+1, 5+2 |
| Leg 2 | 1+0, 2+1, 3+III | 0+1, 1+1, 5+IV |
| Leg 3 | 1+0, 1+1, 2+III | 0+1, 1+1, 5+III |
| Leg 4 | 1+0, 1+1, 2+II | 0+1, 1+1, 5+III |

*Host.—Chiloscyllium indicum.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg.No. C210612.

*Remarks.*—In the armature of the exopod of the third leg *T indicus* resembles *T albidus* Wilson (1911a) and *T flagellans* Wilson (1913) but they differ in the armature of the exopod of legs two and four. The armature of the third leg of *Irodes gracilis* (Heller) is similar to that of *T indicus* and it is also a parasite of elasmobrachs. *I. gracilis* is obviously a *Taeniacanthus* and not an *Anchistrotos* as observed by Ho (1969).

## **Taeniacanthus lagocephali** Pearse
(Fig. 25)

*Taeniacanthus lagocephali* Pearse, 1952, p. 8, figs. 1-4; Yamaguti, 1963, p. 21 ; Ho, 1969, p. 112, figs. 1-5.
*Taeniacanthus subafugu* Yamaguti and Yamasu, 1959, p. 102, pl. 4, figs. 79-89.
*Irodes lagocephali* Pillai, 1963e, p. 124, fig. 7 ; 1967d, p. 1563, fig. 9.

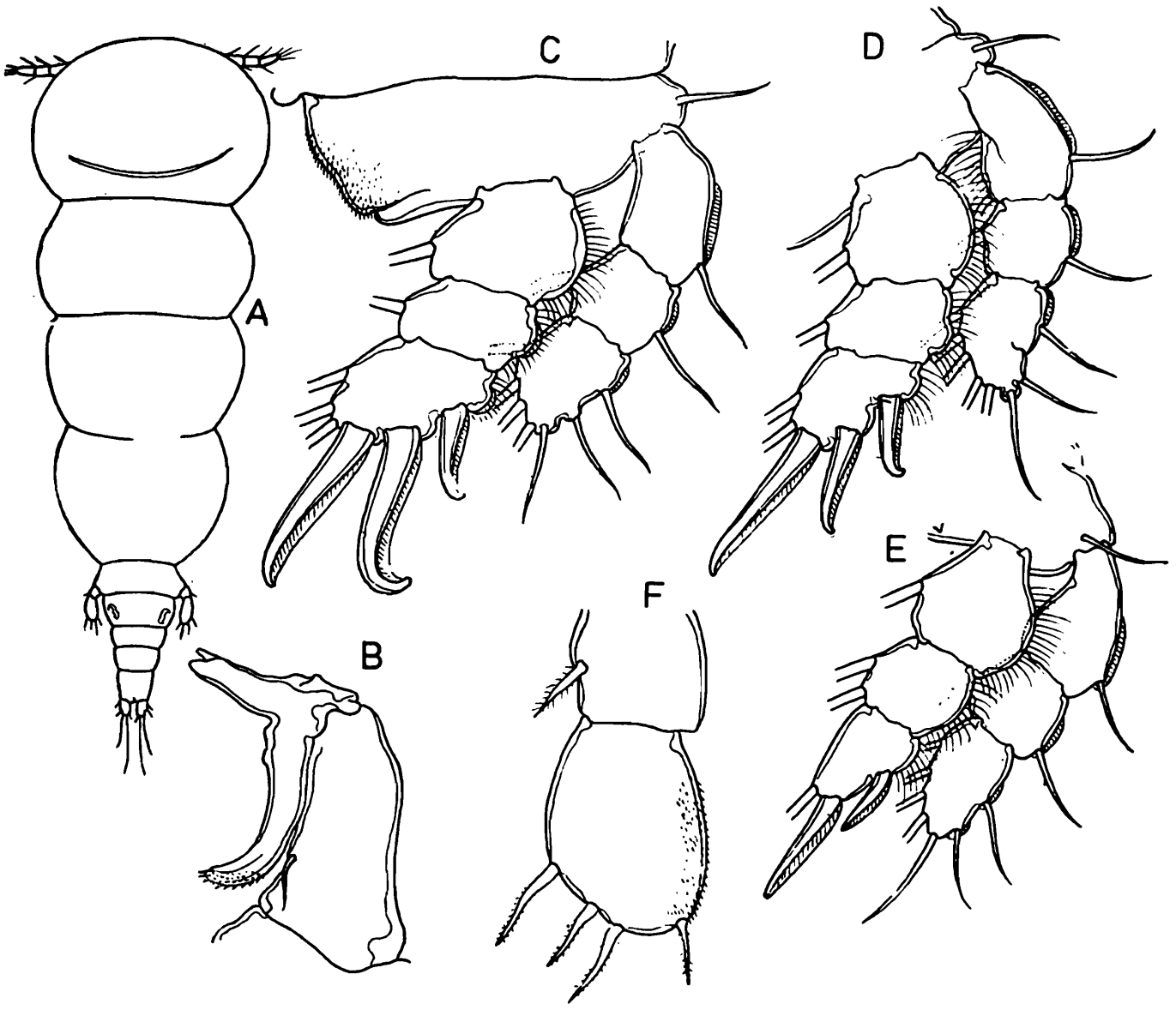


Fig. 25. A-F. *Taeniacanthus lagocephali* Pearse : A, female, dorsal view ; B, maxilliped : C-F, legs 2-5.

*Female.*—Cephalothorax slightly broader than long, anterior and lateral borders rounded, dorsal side with posterior arcuate rib. Thoracic segments two to four large, swollen, subequal in length, not much narrower than cephalothorax. Fifth segment very short, about three times as broad as long. Abdomen three-segmented, segments successively narrowing. Egg sacs long, fairly stout.

Antennule six-segmented, basal segments partially fused. Distal segment of antenna with inner median bulge, inner surface spiny, there are three stout claws. Mandible with broad apical and narrow subapical blade. Maxillule with three setae, one short. Maxilla with two identical processes. Claw of maxilliped proximally

produced, main part of claw parallel to second segment but apically curving inwards, tip bifid, externally tuberculated.

First leg flattened, exopod two-and endopod three-segmented. Endopod of second leg broader than exopod, distal segment armed with three stout claws flanged externally, second claw strongly curved, spines on exopod setiform. Third leg similar to second, distal segment of endopod small and narrowing, second claw less curved. Fourth leg comparatively small, third endopod segment triangular, with two claws. Basal segment of fifth leg large, distal ovate, with four setiform spines, inner border spiny.

*Length.*—2.8 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 7+0 | 1+1, 5+2, |
| Leg 2 | 1+0, 1+0, 3+III | 0+I, 1+I, 4+III |
| Leg 3 | 1+0, 1+0, 2+III | 0+1, 1+I, 5+III |
| Leg 4 | 1+0, 2+0, 1+II | 0+I, 1+I, 4+III |

*Male.*—Cephalothorax comparatively large and semicircular. First thoracic segment indicated by a transverse rib. Thoracic segments two to four successively narrowing, fifth segment fairly long, not much narrower than fourth. Maxilliped modified into a large subchela, distal segment internally spiny and with an inner median seta, claw with two proximal inner setae, apex with a small spinule.

*Length.*—1.0 mm

*Host.*—*Lagocephalus laevigatus*, *L. inermis*, *Spheroides spadiceus.*

*Distribution.*—Gulf of Mexico, Japan, Texas, West Africa, India (Kerala).

## **Taeniacanthus longicaudus** Pillai
(Fig. 26)

*Taeniacanthus longicaudus* Pillai, 1963e, p. 116, fig. 3 ; 1967d, p. 1560, fig. 3.

*Female.*—Cephalothorax subequal in length and width, rostral lobe projecting, anteriorly rounded. Second thoracic segment laterally rounded and postero-laterally overlapping third, latter

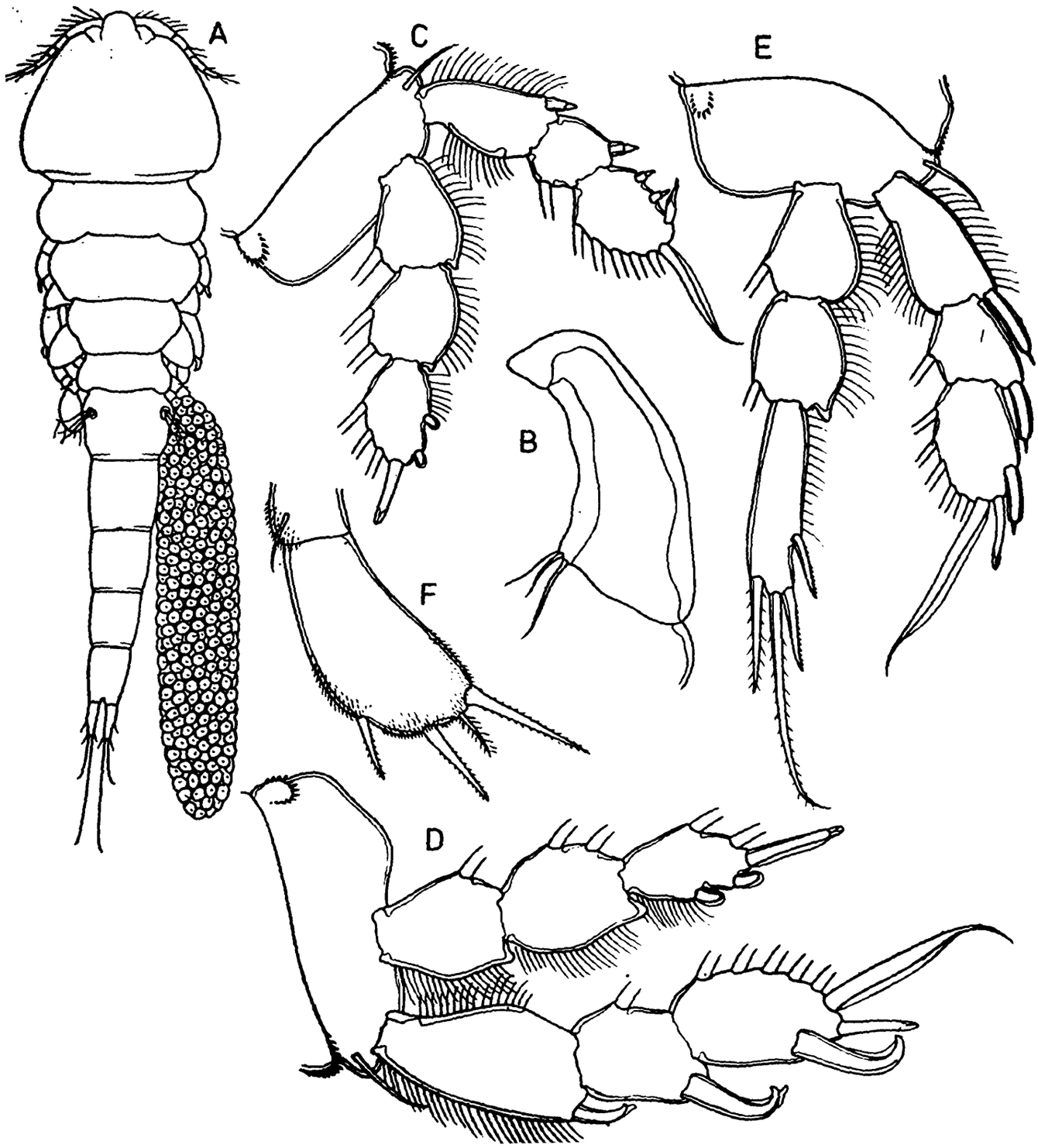


Fig. 26. A-F. *Taeniacanthus longicaudus* Pillai : A, female, Dorsal view ; B, maxilliped ; C-F, legs 2-5.

with irregular lateral borders. Fourth segment transversely oblong. Thoracic segments two to four successively narrowing. Fifth segment expanded at the base of the legs. Genital segment not

enlarged. Abdomen long, four-segmented and narrowing. Distal inner seta of caudal rami twice as long as outer. Egg sacs fairly large, reaching tip of the setae on caudal rami.

Distal segment of antenna irregular in shape, lower border spiny, there are three strong claws and four slender setae. Basal segment of mandible distally produced, blades narrow and unequal. Maxillule with one small and two long setae, paragnath small, pyriform. Maxilla with a sharp spine and two ventrally barbed blades. Claw of maxilliped fused with second segment or absent, inner proximal part of second segment with two setae.

Rami of first leg three-segmented, endopod broad. Rami of second seg subsimilar, first two segments of endopod conically produced at outer distal part, third segment with one long blunt claw and two short ones, all apically flattened. First segment of exopod with one outer spine composed of a broad base and spine-like distal part. Second segment with one spine, third with four, fourth spine externally winged and internally plumose, apically drawn out into a filament. Third leg much longer than second, exopod longer than endopod, first exopod segment with a short but stout outer claw, second with a similar but longer claw, third with a similar claw, an apically blunt spine resembling that on the endopod of second leg and a stout spine like that on the exopod of the second leg. The flange of the claws distally projecting making the claws appear bifid. Endopod of fourth leg longer than exopod, increase in length mainly that of the third segment, second segment with inner distal process. third segment with two spines and two setae, exopod segments with one cylindrical winged spine each, with an apical spinule, third segment also with a blunt spine and a large spine similar to those on the exopod of other legs. Basal segment of fifth leg with a seta and a patch of spinules, second segment distally broad, with three spines and a small seta, distal border spiny, this limb resembles that of *Bomolochus*.

*Length.*—3.2 mm

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+1, 1+0, 7 | 0+1, 1+1, 5+1 |
| Leg 2 | 1+0, 2+0, 3+III | 0+I, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+III | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, 2+II | 0+I, 1+I, 5+III |

*Host.—Saurida tumbil.*

*Distribution.*—India (Kerala).

*Holotype.*—female in the Narional Zoological Collection at Zoological Survey of India, Calcutta, Reg. No. C2107/2.

*Remarks.*—The armature of legs two to five is very characteristic and distinguishes this species.

**Taeniacanthus narcini** Pillai
(Fig. 27)

*Taeniacanthus narcini* Pillai, 1963e, p 114, fig. 2 ; 1967d, p. 1559, fig. 2.

*Female.*—Cephalothorax comparatively small, with suture indicating fusion of first thoracic segment. Second thoracic segment only slightly narrower than cephalothorax, transversely rectangular, third segment narrower than second, laterally rounded, fourth segment still more narrowed, transversely oblong. Fifth segment very small. Genital segment like the first abdominal segment. Abdomen four-segmented, narrowing, anal segment longest. Egg sacs reaching the tip of the setae on caudal rami.

Maxillary hook stout and conical. Distal segment of antenna remotely resembling that of *T indicus*, ventral part spiny, apex with four strong claws, two setae, linguiform prolongation and lamellar process. Basal segment of mandible distally produced, blades subsimilar. Maxillule with two long and two short setae. Maxilla with two subsimilar narrow spiny blades. Maxilliped with irregular second segment carrying one distal and two inner setae.

First leg moderately flattened, exopod narrow, endopod fairly broad. Exopod of second leg longer than endopod, first and second segments with one each and third with three barbed and flagellated claws, third segment with an additional long spine, externally barbed and internally plumose. Third endopod segment with three spines. Third leg longer than second, endopod shorter but broader than exopod, its third segment with three spines, segments one and two of exopod with one each and third with three spines. Endopod

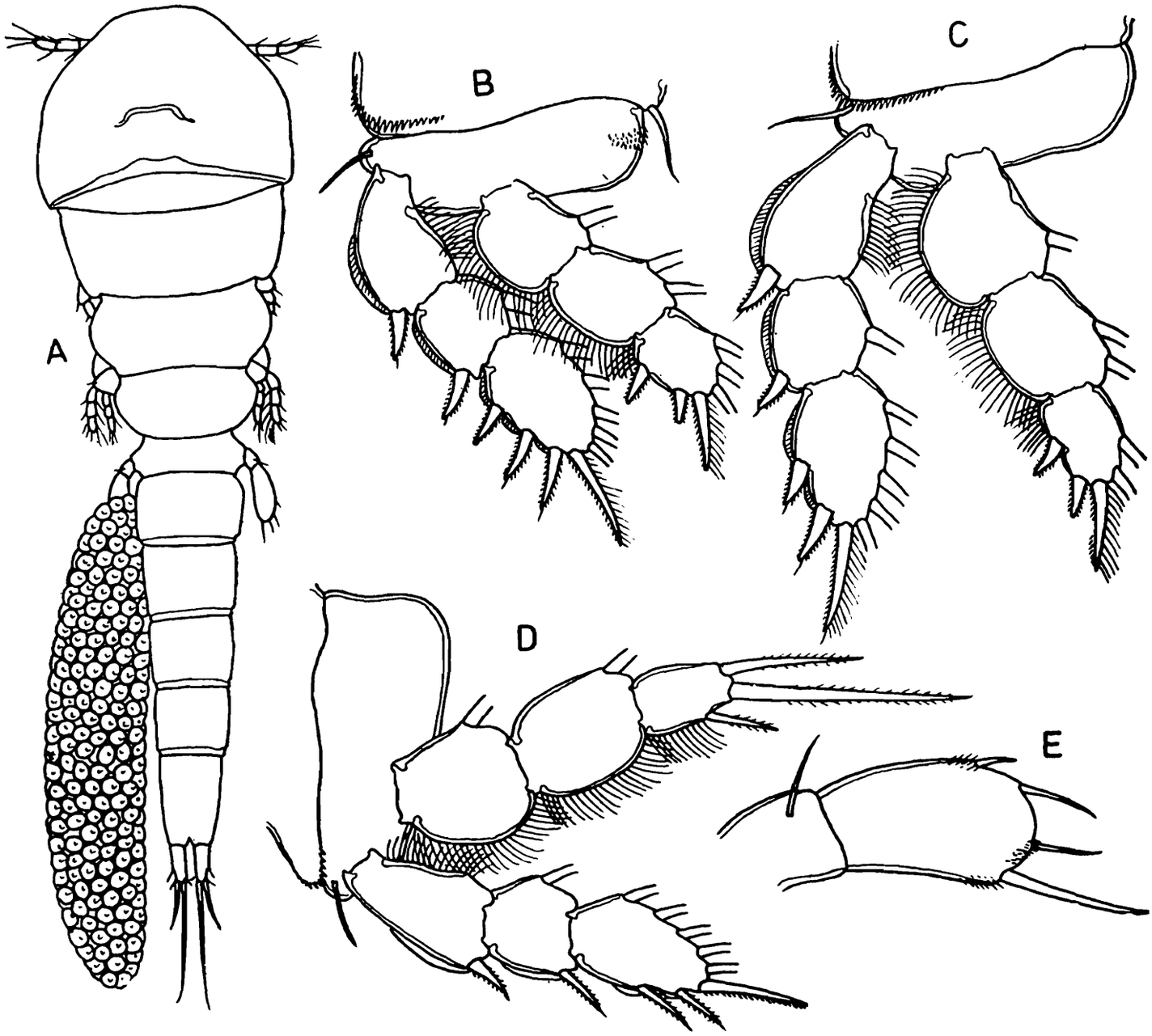


Fig. 27. A-E, *Taeniacanthus narcini* Pillai : A, female, dorsal view ; B-E, legs 2-5.

of fourth leg clearly broader than exopod, third segment reduced in size, with three long spines. First two segments of exopod with one each and third with three rather slender spines. All the exopod segments with frilled border. Fifth leg moderately flattened, basal segment large, with one seta, second with three spines and one seta, third spine very long, there are three small patches of denticles.

*Length.*—2.4 mm

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 2+0, 5 | 1+1, 5 |
| Leg 2 | 1+0, 2+0, 3+III | 0+1, 1+I, 5+IV |
| Leg 3 | 1+0, 2+0, 2+III | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 5+III |

*Host.—Narcine timlei.*

*Distribution.*—India (Kerala).

*Holotype*—female in the National Zoological Collection at Z.S.I., Calcutta., Reg. No. C2108/2.

### **Taeniacanthus tetradonis** (Bassett-Smith)

*Bomolochus tetradonis* Bassett-Smith, 1898a, p. 3, pl. 1, fig. 2.

*Host.—Tetradon oblongus.*

*Distribution.*—India (Bombay).

*Remarks.*—This species has never been redescribed since its creation by Bassett-Smith. Bassett-Smith's description is helpful only in understanding the general shape of the body which is very close to that of *T yamagutii* (Shiino). They may perhaps be synonymous. But Shiino observed that they differ in the armature of the legs and the structure of the oral appendages which however are not clear from the original description. Rediscovery of this species alone can help a decision whether *T yamagutii* is the same as *T tetradonis.*

## Genus **Parataeniacanthus** Yamaguti

*Parataeniacanthus* Yamaguti, 1939a, p. 409 ; 1963, p. 23 ; Pillai, 1963e, p. 118.

*Diagnosis.*—First thoracic segment incompletely fused with cephalon, the resulting cephalothorax comparatively very large. Thoracic segments two to five narrow, successively narrowing.

Genital segment not enlarged. Abdomen very long and slender, four-segmented. Caudal rami longer than broad. Antennule and antenna as in *Taeniacanthus*. Maxillary hook present. Mandible, maxillule and maxilla as in *Taeniacanthus*, maxillule with four setae, paragnath present. Maxilliped and legs as in *Taeniacanthus*.

Male with swollen genital segment, maxilliped stout and subchelate.

Parasites of teleosts.

Type-species.—*P. pseudorhombi* Yamaguti.

*Discussion.*—The two characters which distinguish *Parataeniacanthus* from *Taeniacanthus* are the incomplete fusion of the first thoracic segment with the cephalon and the presence of a long slender four-jointed abdomen. These differences are of a comparative nature and one can accept or reject them as one fancies. There is in fact a transverse groove on the cephalothorax of *T upenei* Yamaguti, *T narcini* Pillai and *T longicaudus* Pallai and according to Yamaguti's definition they should be placed in *Parataeniacanthus*. But Yamaguti placed *T upenei* under *Taeniacanthus*. *T longicaudus* Pillai has an abdomen as long as that of *P. pseudorhombi* the type species. It appears that all the species of *Parataeniacanthus* can be included in *Taeniacanthus* without changing the existing definition of the latter.

Three species, *P. miles* Pillai, *P. longicervis* Pillai and *P. cynoglossi* Rangnekar and Murti (1961) have been recorded from Indian waters.

The description of *P. cynoglossi* contains so many mistakes that its identity is very uncertain. Rangnekar and Murti have described the maxillary hook as first maxilla, the paragnath of the maxillule as mandible, the mandible as first maxilliped and the true maxilliped as second maxilliped. At any rate this species has the first thoracic segment fully fused with the cephalon and the abdomen is short and only three-segmented. It appears to belong to *Anchistrotos*.

*Key to species of* **Parataeniacanthus**

| | | |
|---|---|---|
| 1. | Exopods of legs three and four modified | *.longicervis* Pillai |
| — | Exopods of legs three and four not modified | *.miles* Pillai |

## **Parataeniacanthus miles** Pillai
(Fig. 28)

*Parataeniacanthus miles* Pillai, 1963e, p. 118, fig. 4 ; 1967d, p. 1560, fig. 5.

*Female.*—Cephalothorax comparatively large, rostral plate low and broad-based. Second thoracic segment long, posterolaterally angular. Fourth segment much narrower than third, transversely expanded. Fifth segment expanded at the base of the legs. Genital segment enlarged, not broader than fifth segment, slightly broader than long. Abdomen long and four-segmented. Caudal rami much longer than broad.

Maxillary hook strong and curved. Distal segment of antenna smooth, with large spiny lobe, a stout claw and four other claws. Basal segment of mandible distally expanded, blades subequal. Maxillule with two long and two short setae. Paragnath distally narrow. Maxilla with two unequal blades and a sharp spine. Second segment of maxilliped short, claw very long, basally transverse and further on parallel to the second segment, last portion bent inwards, carrying a pair of setae, border of the claw beyond the setae crenate and transversely grooved.

Exopod of first leg two-jointed, endopod three-jointed and rather narrow. Claws on exopod of second leg setiform, feebly barbed, basal segment of endopod large, distal segment with three blunt claws, first claw characteristically bent. Third leg similar to second but larger, first claw of third endopod segment only slightly curved. Fourth leg similar to third but distal exopod segment apically slightly bent outwards and longer, third segment of endopod distally narrow, with two winged claws and a long apical spine. Distal segment of fifth leg generally resembling that of bomolochids, with three strong spines and a very short plumose seta, there are four small patches of spinules.

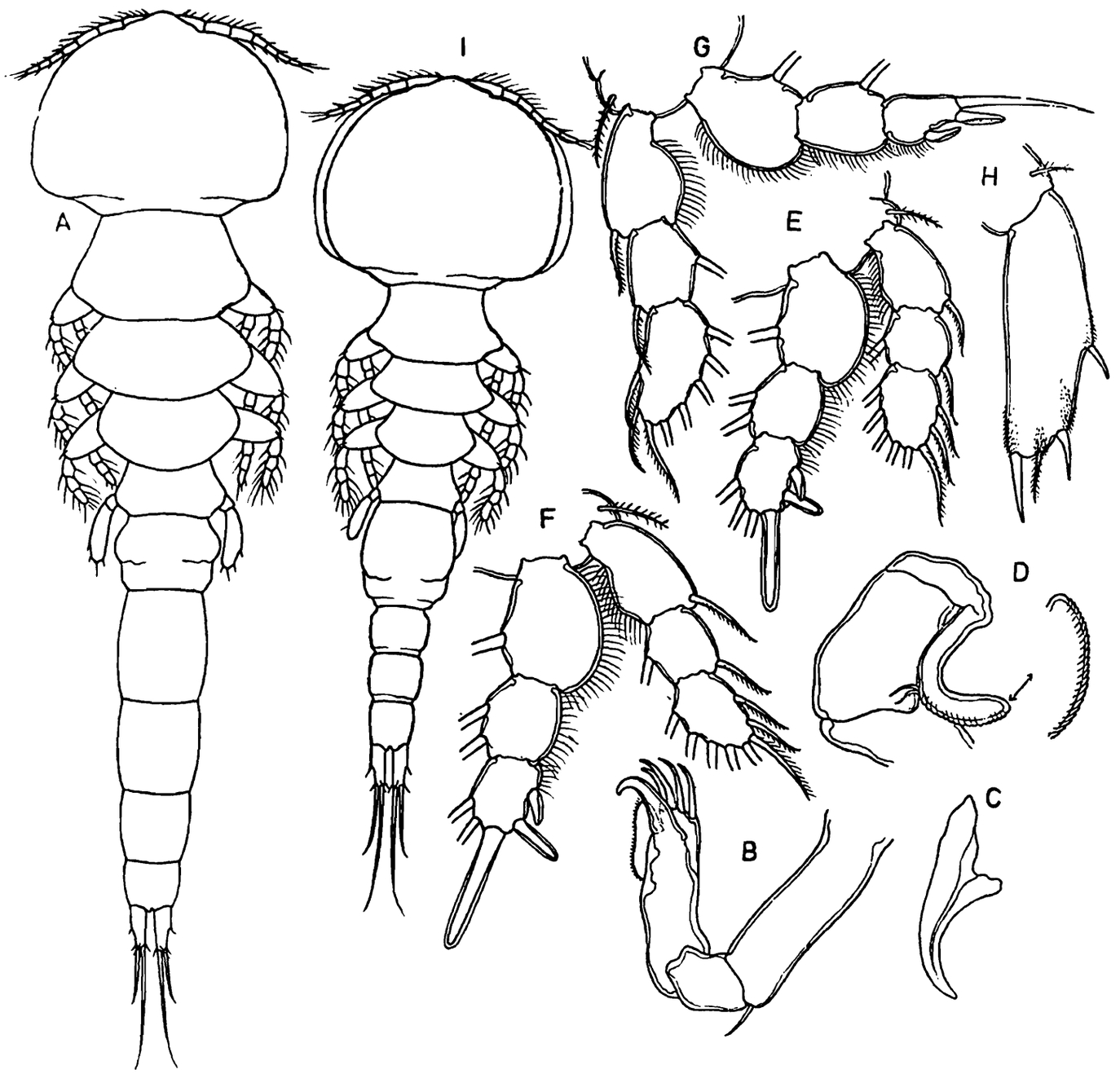


Fig. 28. A-H. *Parataeniacanthus miles* Pillai : A, female, dorsal view ; B, antenna ; C, post-antennular process ; D, maxilliped ; E-H, legs 2-5 ; I, male, dorsal view.

*Length.*—2.4 mm

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 2+0, 1+0, 7 | 0+0, 6+3 |
| Leg 2 | 1+0, 2+0, 3+III | 0+1, 1+I, 5+III |
| Leg 3 | 1+0, 2+0, 2+III | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 5+III |

*Male.*—Cephalothorax broader than in female. Post-cephalothoracic portion similar to that of female but more slender. Fifth thoracic segment remotely triangular. Genital segment large, slightly longer than broad. Abdomen three-segmented, with subparallel sides. Maxilliped modified into a subchela, inner border of distal segment with two rows of blunt spines and a pair of setae, claw with two inner proximal processes, apex narrowed, with a spiniform accessory process.

*Length.*—1.1 mm.

*Host.—Pterois miles.*

*Distribution.*—India (Kerala)

*Holotype.*—Female and *allotype* male in the National Zoological Collection at of Z.S.I., Calcutta, Reg. Nos. C2109/2 & C2110/2.

**Parataeniacanthus longicervis** Pillai
(Fig. 29)

*Parataeniacanthus longicervis* Pillai, 1963e, p. 120, fig. 5 ; 1967d, p. 1562, fig. 6

*Female.*—Cephalothorax with evenly curved lateral borders and straight posterior border. Rostral lobe short and conical. Second thoracic segment long, roughly squarish but broader behind. Third segment subequal to second in length. Fourth segment narrower than third, overlapping fifth. Latter broader than long. Genital segment proximally swollen. Abdomen four-segmented, comparatively long and gradually narrowing. Caudal rami twice as long as broad.

Maxillary hook stout and curved. Third segment of antenna ventrally spiny and distally produced into a linguiform process, there are five slender hooks and one seta. Subapical blade of mandible far removed from the apical. Maxillule with two large and two small setae, paragnath short and pyriform. Distal blades of maxilla long and narrow, ventrally barbed, spine prominent and barbed. Second segment of maxilliped oblong, with two proximal inner setae. Claw curved, remaining parallel to the second segment, its lower border armed with six teeth.

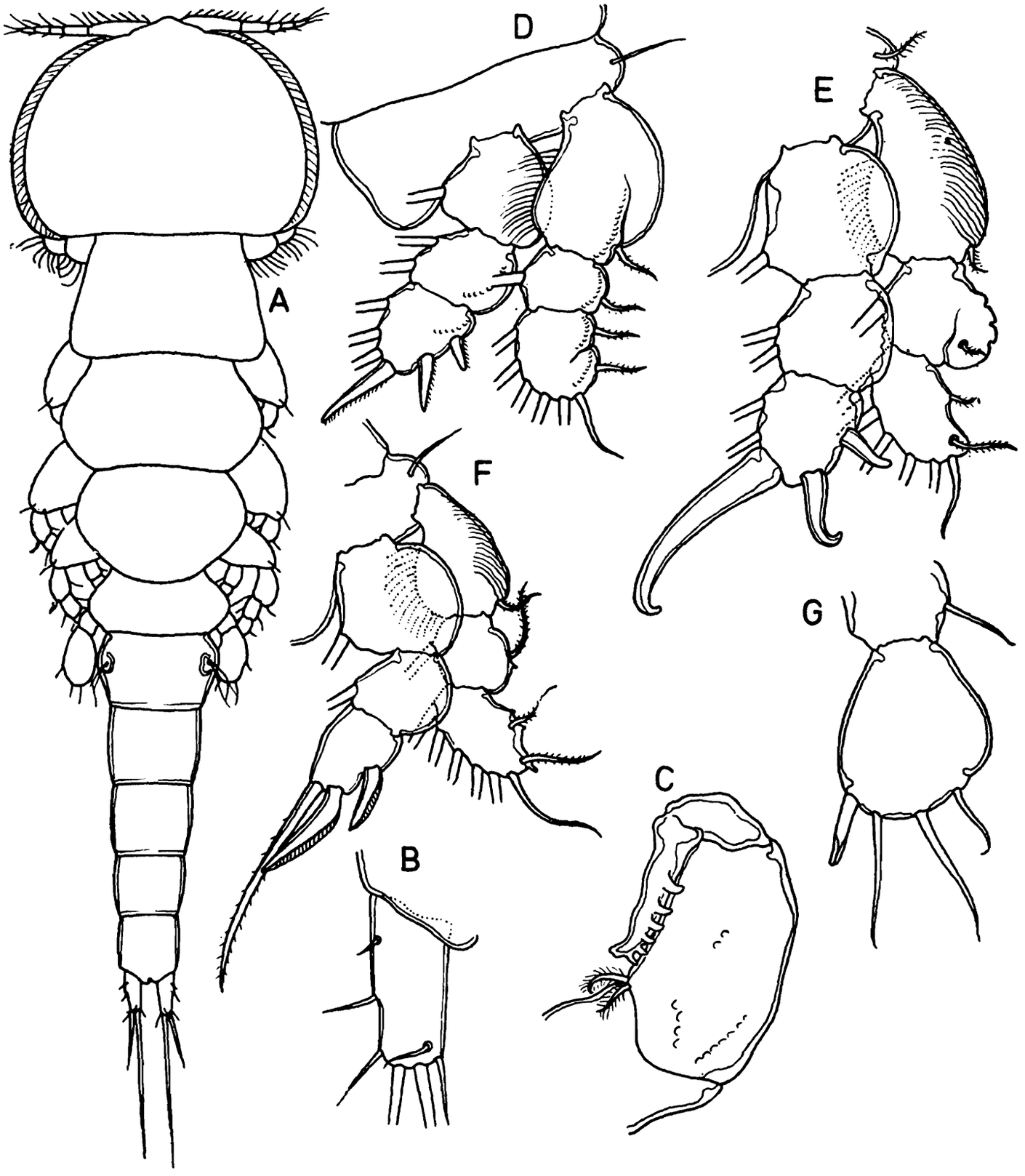


Fig. 29. A-G. *Parataeniacanthus longicervis* Pillai : A, female, dorsal view ; B, caudal ramus ; C, maxilliped ; D-G, legs 2-5.

Rami of first leg three-segmented, comparatively narrow. Rami of second leg, especially their first segment, flattened, spines on exopod very slender and setiform, segments with arcs of denticles

near the outer border. Second and third endopod segments with similar rows of denticles. Third endopod segment armed with three stout claws. Third leg stouter than second, basal exopod segment with an outer wavy ridge and a spinule. Outer part of second segment expanded into a thin lamina cut into four lobes. Third segment distally narrowed and curving outwards, with three spinules. First endopod segment very large, third with three curved strong claws, third claw enormous and apically curved. Fourth leg smallest, basal segment of exopod similar to that of third, second segment without lobes, third segment only slightly curved. Third segment of endopod narrowing, with two winged claws and a very long pectinate spine. Basal segment of fifth leg fairly large, second segment pyriform, with three setiform spines, inner distal spine stout and apically rounded.

*Length.*—2.9 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 6 | 0+I, p+I, 6+2 |
| Leg 2 | 1+0, 2+0, 3+III | 0+I, 1+I, 5+III |
| Leg 3 | 1+0, 2+0, 2+III | 0+I, 1+I, 5+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 5+III |

*Host.*—*Saurida tumbil.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Z.S.I., Calcutta., Reg. No. C2111/2

*Remarks.*—The armature of the maxilliped and legs two to five easily distinguishes this species.

## Genus **Metataeniacanthus** Pillai

*Metataeniacanthus* Pillai, 1963e, p. 122.

*Diagnosis.*—Cephalon fused with first thoracic segment forming moderately large cephalothorax. Second thoracic segment larged, athird and fourth narrower. Fifth segment abruptly enlarge,

transversely oblong. Genital segment narrower than adjacent segments. Abdomen four-jointed, highly swollen and nearly as long as the rest of the body. Caudal rami long, slender, with long plumose setae.

Antennule six-jointed. Third segment of antenna with linguiform extension, lamellar process and hooks. Maxillary hook strongly curved, maxillule with three setae. Maxilliped two-jointed, claw absent. Legs generally as in *Taeniacanthus*.

Parasites of teleosts.

Type-specics.—*M. synodi* Pillai.

**Metataeniacanthus synodi** Pillai
(Fig. 30)

*Metataeniacanthus synodi* Pillai, 1963e, p. 122, fig. 6.

*Female*.—Cephalothorax helmet-shaped, antero-medially angular, widening backwards and postero-laterally drawn out, hind border very slightly concave. Thoracic segments two to four successively decreasing in width, lateral borders rounded. Fifth segment large, transversely oblong and as broad as second thoracic segment, Genital segment very short, narrower than the adjacent segments. Abdomen as long as rest of body or even longer, four-segmented. first segment very large, with convex sides, barrel-shaped, second narrowing, anal segment short. Caudal rami longer than broad. Egg sacs stout, nearly as long as the post-genital part of body.

Maxillary hook stout and strongly curved. Distal segment of antenna short, with two rows of ventral spinules, linguiform extension small and naked, there are four stout hooks and a small lamellar process. Maxillule with three setae. Paragnath two-jointed. One of the blades of the maxilla barbed, the other naked. Maxilliped an irregular chitinised indistinctly segmented plate with one distal and two inner proximal setae, claw absent.

First leg very small, with three-segmented rami. Second leg with qroad subequal rami, first segment of exopod rather long, third segment of endopod with three claws, first two apically blunt

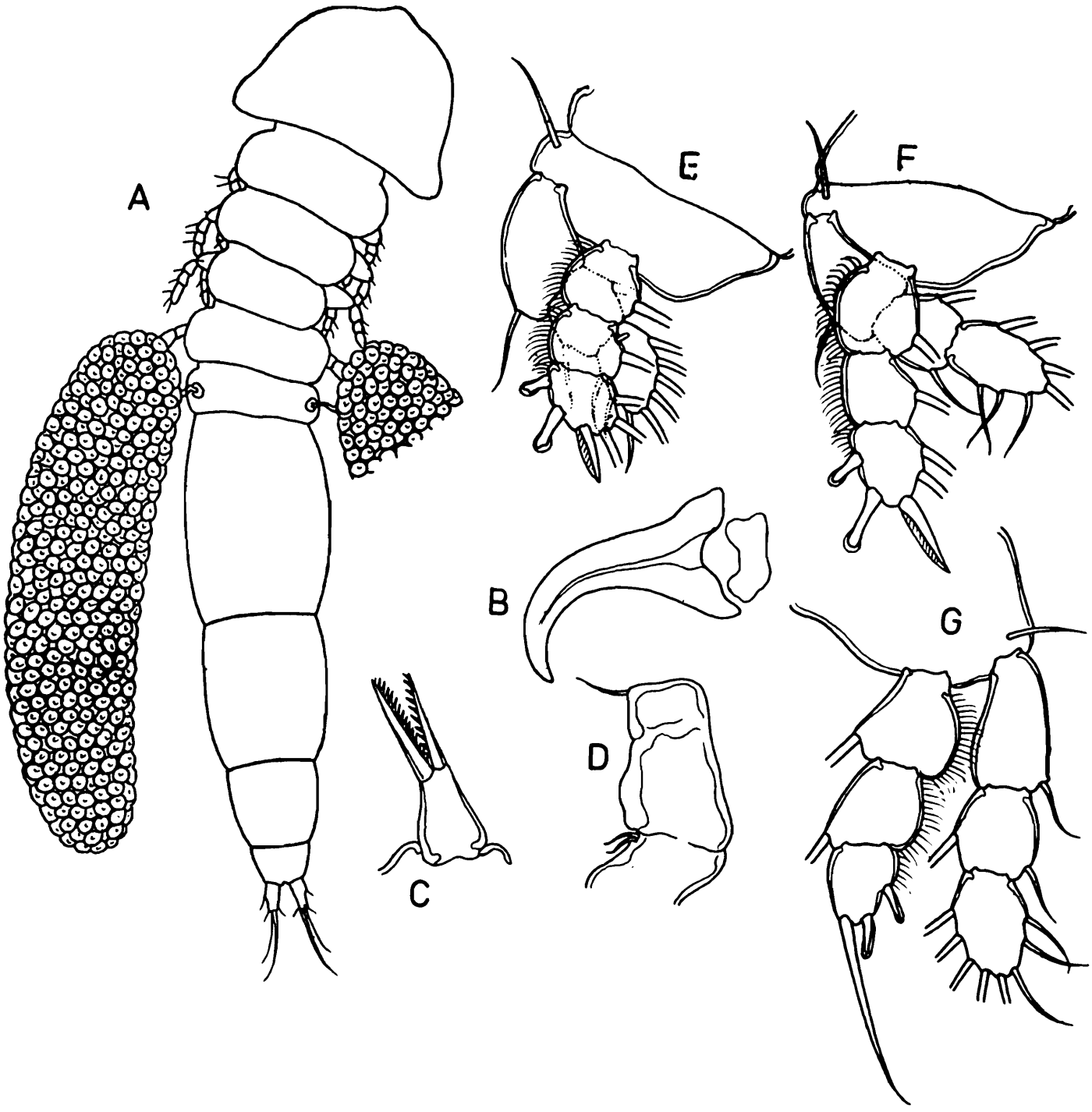


Fig. 30. A-G. *Metataeniacanthus synodi* Pillai : A, female, dorsal view ; B, post-antennular process ; C, maxilla ; D, maxilliped ; E-G, legs 2-4.

and flattened, third claw with outer wing. Third leg similar to second, first segment of exopod elongated, third segment of endopod with claws similar to those on second. Rami of fourth leg broad, exopod longer than endopod, third segment of endopod with two claws and a very long apical spine. Basal segment of fifth leg with a long seta, distal segment regularly narrowing, with four setiform spines, distal part spiny.

*Length.*—2.0 mm

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 2+0, 1+0, 7 | 0+1, 1+1, 5+1 |
| Leg 2 | 1+0, 1+0, 3+III | 0+I, 1+I, 5+III |
| Leg 3 | 1+0, 1+0, 2+III | 0+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 5+III |

*Host.*—*Synodus indicus.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Z.S.I., Calcutta., Reg. No. C2112/2.

## Genus **Pseudotaeniacanthus** Yamaguti and Yamasu

*Pseudotaeniacanthus* Yamaguti and Yamasu, 1959, p. 111 ; Yamaguti, 1963, p. 25 ; Lewis, 1967, p. 5 ; 1968, p. 15 ; Pillai and Hameed, 1974, p. 182.

*Diagnosis.*—Cephalon fused with first thoracic segment forming a cephalothorax, second to fourth segments free, narrowing and covering the basipods of legs. Fifth and genital segments laterally expanded, much narrower than fourth segment. Abdomen four-segmented, as long as the rest of the body or shorter. Caudal rami as long as the last abdominal segment or shorter. Egg sacs long and slender, eggs multiseriate.

Antennule six-segmented, not flattened, nor demarcated into peduncle and flagellum. Antenna three-to four-segmented, third segment short, with linguiform process, claws and setae. Maxillary hooks fused, median. Mandible, maxillule and maxilla taeniacanthid. Maxilliped an unsegmented plate with or without setae or a three-jointed appendage. First leg with three-jointed rami, endopod highly flattened. Rami of legs two to four three-jointed, not flattened. Fifth leg uniramous, two-jointed.

Type-species.—*P. congeri* Yamaguti and Yamasu.

### *Key to species of* **Pseudotaeniacanthus**

1. Abdomen much shorter than cephalothorax, maxillary hooks with rows of spines . . ..2

— Abdomen as long as cephalothorax or slightly shorter, maxillary hooks with transverse ridges .3

2. Maxillary hooks contiguous, not fused, female maxilliped with setae .*congeri* Yamaguti and Yamasu

— Maxillary hooks fused, female maxilliped without setae .*puhi* Lewis

3. Free pedigerous segments narrower than cephalothorax .*Pseudotaeniacanthus* sp. Lewis

— Free pedigerous segments as broad as or broader than cephalothorax .*longicauda* Pillai and Hameed

## **Pseudotaeniacanthus longicauda** Pillai and Hameed (Fig. 31)

*Pseudotaeniacanthus longicauda* Pillai and Hameed, 1974, p. 175, figs. 1-17.

*Female.*—Cephalothorax roughly conical. Second thoracic segment slightly broader than cephalothorax, third longer but narrower than second, fourth still more narrow, segments two to four postero-laterally expanded into overlapping lobes. Fifth segment much narrower than fourth, bulged at the base of the legs. Genital segment as broad as fifth segment but slightly longer. Abdomen very long, as long as cephalothorax and the first three free segments combined, four-segmented and narrowing. Caudal rami nearly as long as the last abdominal segment. Egg sacs overreaching caudal rami.

Antennule six-to seven-segmented, nearly of the same width throughout. Antenna four-segmented, third segment produced into a linguiform process with a large claw at its base, fourth segment indistinct, with four claws and three setae. Maxillary hooks fused into an H-shaped structure, each half composed of a two-jointed anterior process and a claw-like posterior process, the whole attached to an irregular plate. Each segment of the anterior process with combs of spinules. Mandible with two strong distal spines. Maxillule with four short setae. Maxilla with two sharp dissimilar spines. Maxilliped three-segmented, third segment a long curved spine carrying two small proximal spines.

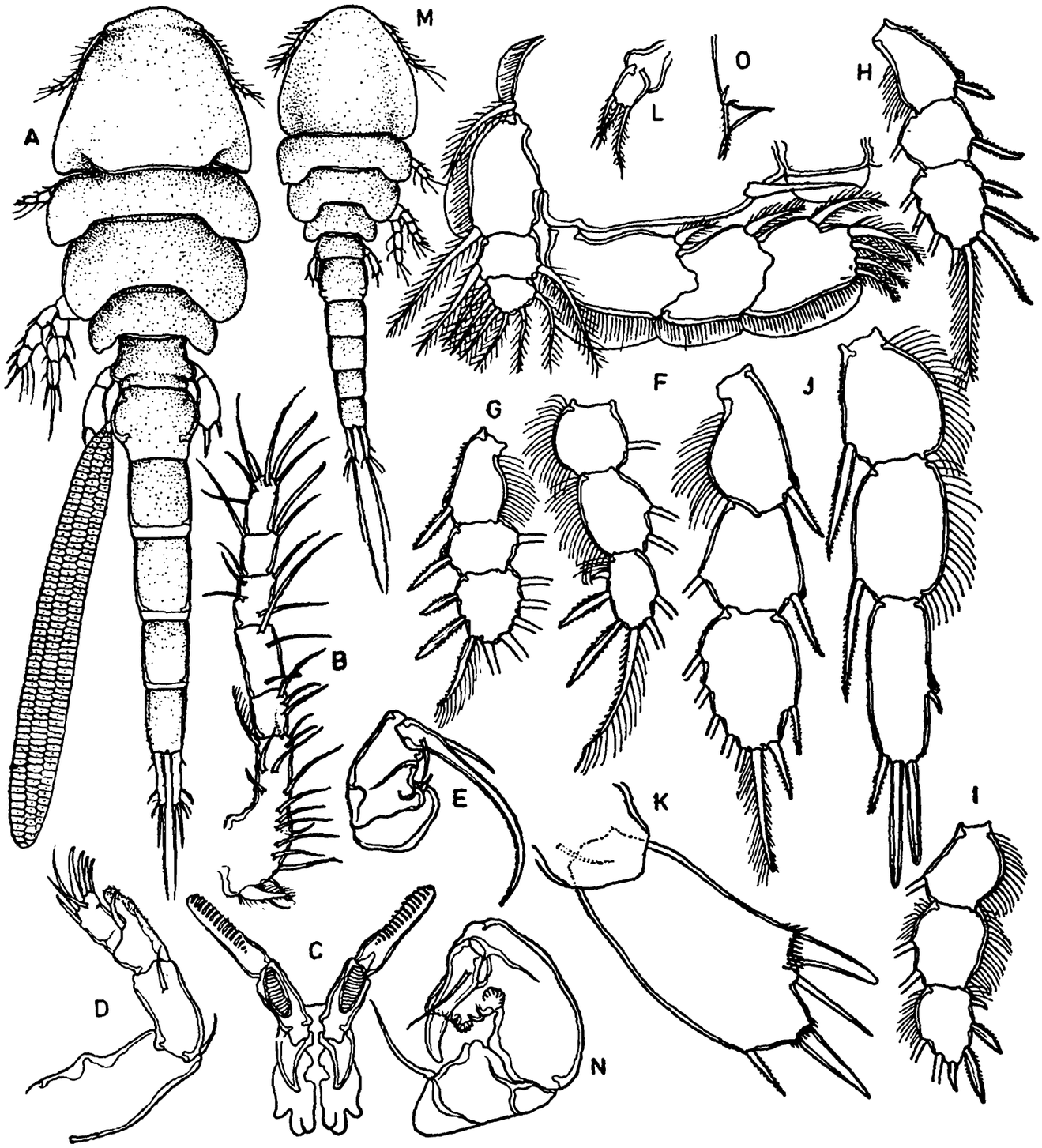


Fig. 31. A-O. *Pseudotaeniacanthus longicauda* Pillai and Hameed : A, female, dorsal view ; B, antennule ; C, post-antennular process ; D, antenna ; E, maxilliped ; F, leg 1 ; G, leg 2 ; H, leg 3, exopod ; I, same, endopod ; J, leg 4 ; K, leg 5 ; L, leg 6 ; M-O, male ; M, male, dorsal view ; N, maxilliped ; O, leg 6.

Protopod of first leg highly expanded, exopod narrow and three-segmented, without spines, basal segment with broad outer flange.

Endopod flat, three-segmented, remaining parallel to the basipod, segments without spines. Legs two and three sub-similar, with narrow three-jointed rami, exopod segments and third endopod segment without spines. Fourth leg longer than second and third, endopod longer than exopod, with spines and no setae. Fifth leg two-jointed, with three distal spines and one spine-like seta, inner distal spine stout, with basal cluster of spinules.

*Length.*—2.4 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 5 | p+1, 1+1, 6 |
| Leg 2 | 1+0, 2+0, 3+III | 0+I, 1+I, 5+III |
| Leg 3 | 1+0, 2+0, 2+IV | 0+I, 1+I, 4+IV |
| Leg 4 | I+0, I+0, IV | 0+I, 1+I, 5+III |

*Male.*—Body generally like that of female. Genital segment comparatively small. Second segment of maxilliped with two adhesion pads, third segment converted into a short strong claw.

*Length.*—1.4 mm.

*Host.—Pisodonophis cancrivorus.*

*Distribution.*—India (Kerala).

*Holotype* female and *allotype* male in the National Zoological collection at Z.S.I., Calcutta.

## Genus **Anchistrotos** Brian

*Anchistrotos* Brian, 1906, p. 32 ; Yamaguti, 1963, p. 22 ; Pillai, 1963e, p. 111 ; Lewis, 1967, p. 9.

*Diagnosis.*—Head fused with first thoracic segment to form a comparatively large cephalothorax, with small but distinct rostral lobe. Free thoracic segments much narrower than cephalothorax. Genital segment not enlarged, only slightly broader than adjacent segments. Abdomen three-to four-jointed. Eggs polygonal.

Antennule basally rather broad. Post-antennal process (maxillary hook) large. Antenna three-jointed, third segment with small spinules. Oral appendages generally as in *Taeniacanthus*. Rami of first leg flattened, of legs two to four three-jointed, spines on exopod weak. Fifth leg two-jointed.

Parasites of teleosts.

Type species.—*A. gobii* Brian

*Discussion.*—As already indicated this genus still lacks a precise definition. The species so far placed under it differ so widely that no definition would apply to all. A scrutiny of the discussion on the genus by Lewis shows this clearly. The unsatisfactory description of the type species adds to the confusion.

Yamaguti (1963) placed nine species in this genus. Since then Lewis (1967) described *A. moa* and Pillai (1962) *A. sauridi*. The last species alone occurs in Indian waters.

### **Anchistrotos sauridi** Pillai

*Anchistrotos sauridi* Pillai, 1963e, p. 126, fig. 8.

*Female.*—Cephalothorax nearly circular, with narrow membranous flange, rostral process fairly large, apically rounded. Thoracic segments two to four much narrower than cephalothorax, successively overlapping and narrowing, fourth overlapping fifth segment. Genital segment slightly broader than fifth segment. Abdomen four-segmented, third segment very short. Egg sacs elongate oblong, with large polygonal eggs.

Antennule five-segmented, basal segment large and fairly deep. Post-antennular process large. Third segment of antenna with two rows of small denticles extending on to the linguiform extension, hooks four, moderately stout. Mandible with similar but unequal blades. Maxillule with four slender setae, paragnath apically bilobed. Apical blades of maxilla slender and subsimilar. Maxilliped an irregularly rectangular plate with two median inner setae.

Exopod of first leg narrow, endopod broad, both two-jointed. Legs two to four with three-jointed rami, spines on exopod weak. Distal segment of fifth leg broad, spines setiform.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+2, 7 | 3+1, 5 |
| Leg 2 | 1+0, 2+0, 4+II | 0+I, 5+III |
| Leg 3 | 1+0, 2+0, 2+II | 0+I, 1+I, 6+III |
| Leg 4 | 1+0, 1+0, III | 0+I, 1+I, 6+III |

*Length.*—1.6 mm.

*Host.—Upeneus vittatus, Saurida tumbil.*

*Distribution.*—India (Kerala).

*Holotype.*—female in the National Zoological Collection at Z.S.I., Calcutta.

## Family CHONDRACANTHIDAE

*Diagnosis.*—Body considerably varying in shape, with one or more trunk processes. Females comparatively large, often greatly transformed, without segmentation. Male a pigmy, with segmentation, attached to the ventral side of the abdomen of the female. Head not fused with first thoracic segment, thoracic segments fused with genital segment to form a variously shaped trunk. Abdomen small, with candal rami. Egg sacs with multiseriate eggs.

Antennule with reduced segmentation, generally two-jointed. Antenna two-jointed, uncinate. Mouth parts consisting of falcate mandible with bilateral denticulation distally, maxillule small, maxilla large, main claw denticulated unilaterally. Maxilliped three-jointed and subchelate. Legs always modified and reduced in number.

*Discussion.*—Because of the presence of pigmy males chondracanthids were till recently included in the suborder Lernaeopodoida. But Oakey (1930) pointed out their similarity with Cyclopoida and transferred them to the latter suborder.

The female exhibits a bewildering variety of shapes and because of this a very large number of genera were created. Oakley discarded many and created a few. In a recent revision of the family Ho (1970a) invalidated twelve genera and accepted in all thirty genera including the one he himself created.

The family is divided into two subfamilies, Chondracanthinae and Lernaentominae. The latter differs from the former in the great elongation of the head. Consequently the antennules and antennae remain at the anterior end and the oral appendages far behind.

Though chondracanthid females differ widely in shape they show unusual conservatism in the structure of the oral appendages. The mandible is two-jointed with the distal joint bilaterally serrated. There is a lobate paragnath which was previously designated as the mandibular palp. The maxillule is a small lobe. The maxilla is two-jointed, with large basal segment, distal segment has a basal spine and distal ventral row of teeth. Maxilliped is three-jointed and is often armed. Though the oral appendages may differ in detail the fundamental pattern is the same, emphasising the homogenity of the family. This is further evident in the monotonous uniformity exhibited by the males. As observed by Ho (1970a) "the male is permanently carried by the female and receives less selective pressure from the environment, thus exhibiting less adaptive radiation than its carrier"

## Subfamily CHONDRACANTHINAE

*Diagnosis.*—Body with or without processes on head, neck or trunk. Attachment to the host effected by the antennae, latter uncinate, clavate, lanceolate or apically trifid. Mouth parts on the cephalon. Neck if present short, except in *Strabax* and *Medesicaste*.

*Discussion.*—*Strabax* and *Medesicaste* differ from the other genera in the presence of a long neck similar to that of Lernaentominae. But Ho correctly placed them in Chondracanthinae as their oral appendages are placed close to the antennae.

*Key to genera of* CHONDRACANTHINAE

1. First and second trunk segments forming a long slender neck . **Medesicaste** Kroyer
— First and second trunk segments not forming a long slender neck .2

2. Trunk with anterior and posterior processes .3
— Trunk without processes .4

3. Trunk with one pair of legs . **Protochondracanthus** Kirtisinghe
— Trunk with two pairs of modified legs . **Chondracanthus** Delaroche

4. Antenna bifid . **Ceratochondria** Yu
— Antenna not bifid . **Heterochondria** Yu

## Genus **Chondracanthus** Delaroche

*Chondracanthus*, Ho, 1970a, p. 152.

*Diagnosis.*—Head not fused with any of the trunk segments, with or without processes. First two pedigerous segments forming a neck, others forming an enlarged trunk with processes. Genital segment and abdomen fused. Antennule fleshy. Antenna uncinate. Legs two pairs, modified, fleshy, bi-or trilobate.

Type-species.—*C. zei* Delaroche.

*Discussion.*—A considerable number of species has been assigned to this genus. According to Ho out of the seventy nine species described only twenty three are valid. Even now the genus is quite heterogeneous. I am not sure whether *C. elongatus* Bassett-Smith really belongs to this genus or that it should be placed under *Protochondracanthus*. It is rather difficult to decide whether the anterior processes on the trunk in these two genera are legs or body processes.

### **Chondracanthus elongatus** Bassett-Smith
(Fig. 32)

*Chondracanthus elongatus* Bassett-Smith, 1898a, p. 13, pl. 6, figs. 4-6 ; Yamaguti 1963, p. 273.

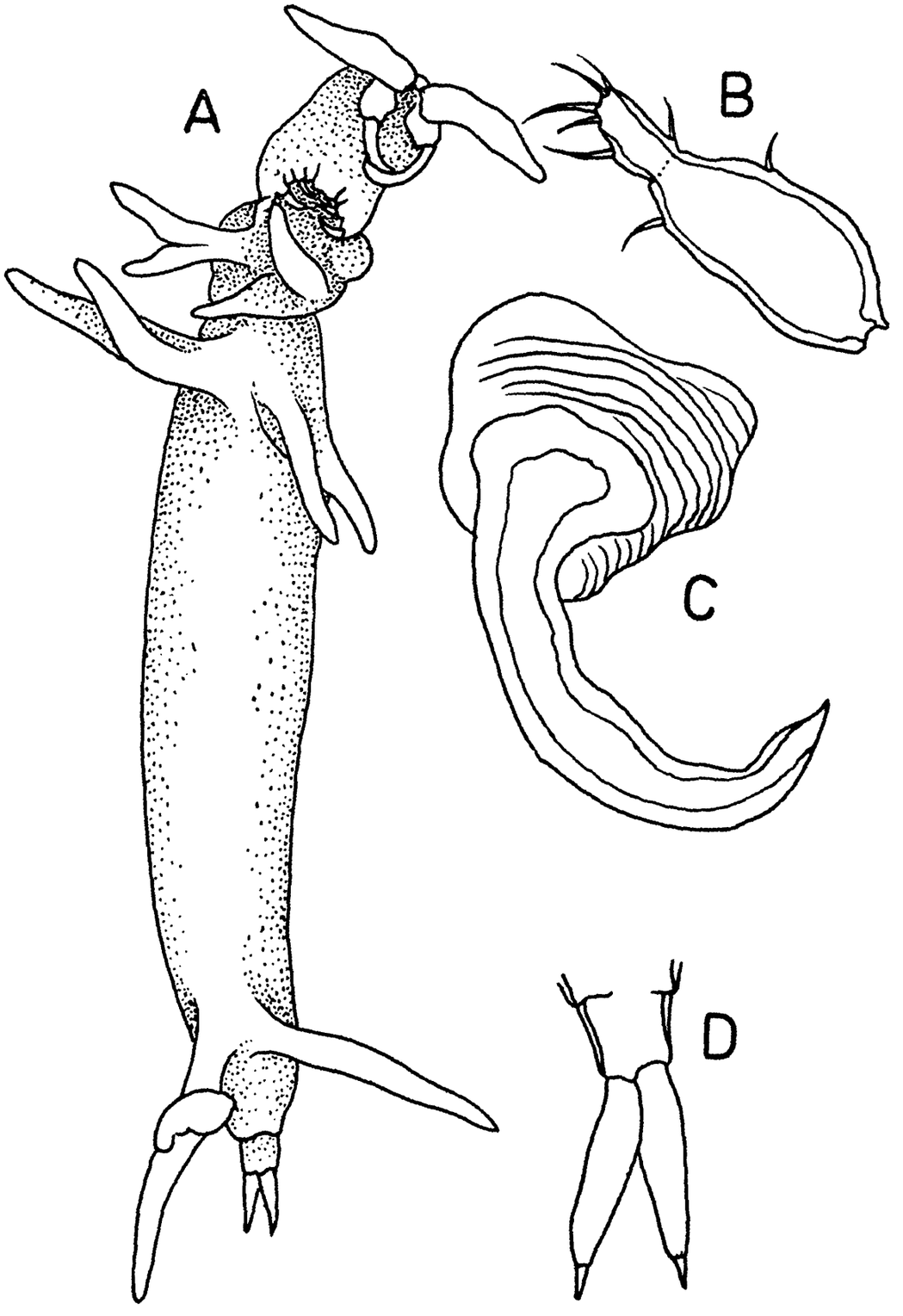


Fig. 32. A-D. *Chondracanthus elongatus* Bassett-Smith : A, female, dorsal view ; B, antennule ; C, antenna ; D, caudal ramii.

*Female.*—Body rather elongated. Cephalon roughly rectangular, longer than broad. First two trunk segments forming a neck not much narrower than cephalon or trunk. Trunk elongate fusiform, broader than cephalon. Abdomen distinct. Caudal rami longer than abdomen. Trunk with two pairs of anterior and one pair of posterior processes, former bilobed and latter unbranched. First trunk process smaller than second. Posterior processes much longer than the rest. Antennule indistinctly two-jointed and sparsely setose. Antenna strongly curved, basal segment rather broad, distal slender.

*Length.*—6.0 mm.

*Host.*—Sole.

*Distribution.*—Bombay.

*Holotype.*—female in the British Museum (N.H.) London.

*Remarks.*—This species does not seem to have been described since its creation. According to Bassett-Smith it closely resembles *P. alatus* (Heller). The above description is based on the type in the British Museum (N.H.).

## Genus **Protochondracanthus** Kirtisinghe

*Protochondracanthus* Kirtisinghe, 1950, p. 85 ; Ho, 1970a, p. 186.
*Chondracanthus* Heller, 1868, p. 231 (in part); Pillai, 1964*b*, p. 76.

*Diagnosis.*—Body long and somewhat dorso-ventrally flattened. Head not fused with any of the trunk segments. Thoracic segments fused into a long trunk bearing two pairs of anterior processes and one pair of posterior processes. Head with or without processes. Antennule two-jointed, basal joint large flattened, distal small and setose. Antenna falcate. Maxillule a stout apically bifid claw. Maxilla with stout basal segment and slender distal segment carrying a ventral distal flange. Maxilliped three-jointed, distal joint with well marked unguis.

First leg associated with the first body process, basipod with a seta, rami one-jointed, exopod with setae or spines, endopod unarmed or with one seta. First body process bilobed, second long and slender, with or without apical spinules.

Type-species.—*P. alatus* (Heller).

*Discussion.*—Kirtisinghe (1950) who created this genus withdraw it later finding that his species is the same as *Chondracanthus alatus* Heller. Yamaguti (1963) restored it and Ho (1170a) upheld Yamaguti's action though for different reasons.

According to Ho *Protochondracanthus* differs from *Chondracanthus* in having only a single pair of unmodified legs. According to him what previous authors described as the first leg is the body process. It should however be pointed out that the body process in both species described here is closely associated with the first pair of legs and is also biramous. It can very well be a pair of modified legs. Since the body processes of chondracanthids are of unknown homology I am for the present accepting Ho's opinion.

*Key to species of* **Protochondracanthus**

1. Head postero-laterally produced into angular processes ..... *.alatus* (Heller)
-- Head postero-laterally not produced into angular processes ..... *.trilobatus* (Pillai)

## **Protochondracanthus alatus** (Heller)
(Fig. 33)

*Chondracanthus alatus* Heller, 1868, p. 231, pl. 23, fig. 3 ; Bassett-Smith, 1898a p. 13 ; Kirtisinghe, 1956, p. 20 ; 1964, p. 48, figs. 7-9 ; Pillai, 1964b, p. 76 figs. 109-120 ; 1967d, p. 1570, fig. 23.
*Protochondracanthus psettodes* Kirtisinghe, 1950, p. 85, figs. 44-51.
*Protochondracanthus alatus* Ho, 1970a, p. 187.

*Female.*—Cephalon roughly triangular, postero-laterally produced into triangular backwardly directed processes, anteriorly rounded, dorsal side with three prominent ribs. Cephalon connected to trunk through a narrow neck. Trunk long, dorso-ventrally flattened. Antero-lateral parts with two pairs of body processes, first pair bilobed, composed of small anterior and large posterior lobe, closely associated with the first pair of legs and situated on the ventral side of the trunk. Second body processes originating from the antero-lateral parts of trunk and projecting outwards and backwards, very long and apically armed with one to three small spines.

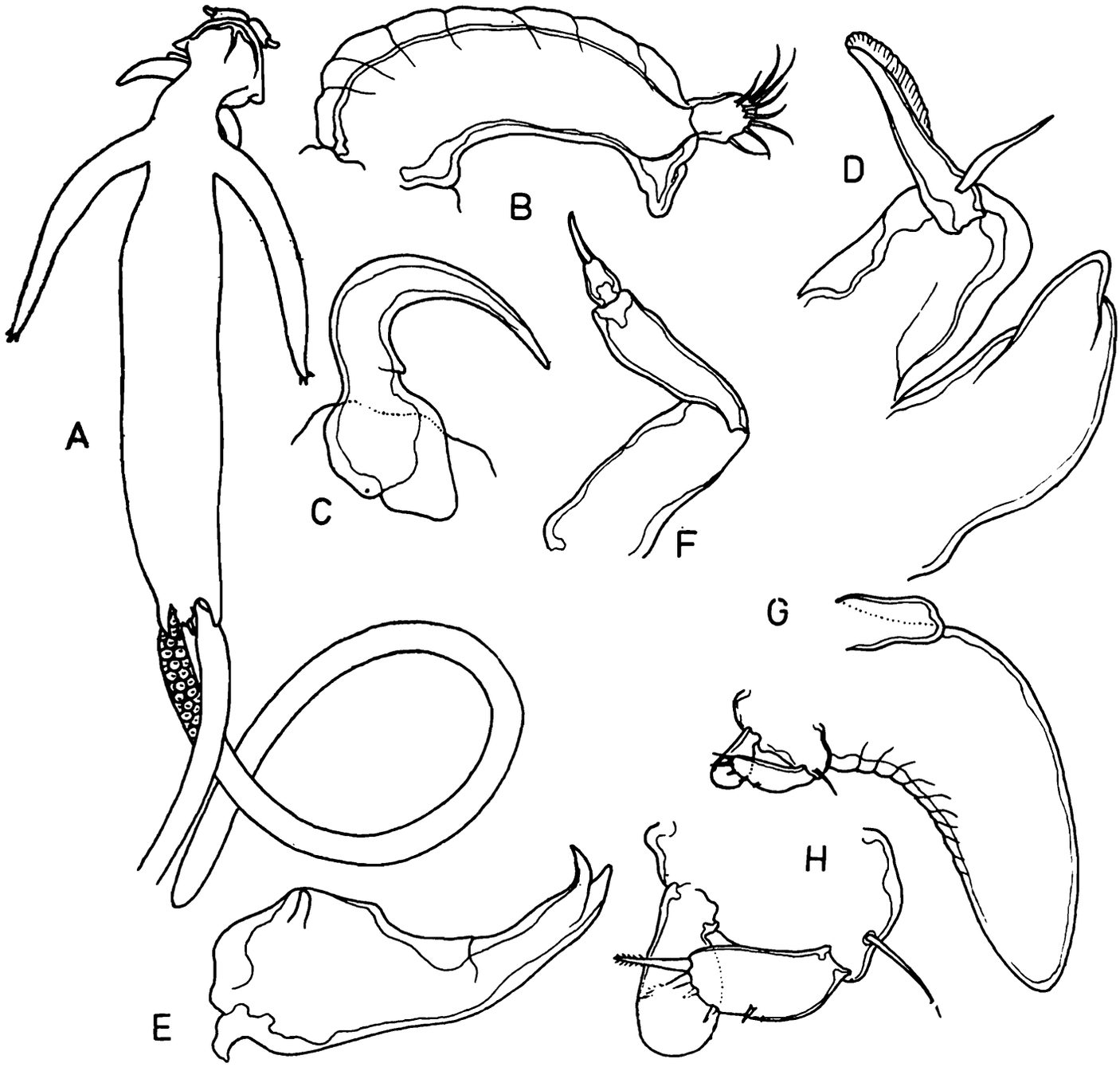


Fig. 33. A-H. *Protochondracanthus alatus* (Heller) : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible ; E, maxilla ; F, maxilliped ; G, leg 1 and trunk process ; H, leg 1 enlarged.

Postero-lateral parts of trunk produced backwards into a pair of triangular processes. Genital segment fused with abdomen. Caudal rami very small. Egg tubes very slender, longer than body.

Antennule two-segmented, first segment enlarged and flattened, without setae, its distal inferior part produced into a conical ventrally directed process, distal segment longer than broad, with a

cluster of about eight setae. Antenna a strongly curved claw with an incomplete proximal partition. Maxillule a stout apically bifid claw with a small basal process. Maxilla composed of a stout basal segment, distal segment slender, with a basal inner spine, dista ventral part with a frilled flange. Maxilliped three-jointed and unarmed, third segment with long apical claw.

First leg biramous, rami one-jointed flattened lobes, basipod with long outer seta, exopod roughly oblong, with three short outer and two long barbed distal spines, endopod with proximal inner constriction, unarmed, nearly as large as exopod, other legs absent.

*Length.*—6.0 mm.

*Host.*—*Psettodes erumei.*

*Distribution.*—Singapore, Bombay, Sri Lanka, Kerala.

**Protochondracanthus trilobatus** (Pillai)
(Fig. 34)

*Chondracanthus trilobatus* Pillai, 1964b, p. 78, figs. 121-132 ; 1967d, p. 1570 fig. 24.

*Female.*—Cephalon comparatively large, its anterolateral parts forming rounded lobes making the frontal border trilobed. Trunk elongated, regularly narrowing backwards, postero-laterally produced into a pair of backwardly directed processes overreaching the abdomen. There are two pairs of anterior trunk processes, first pair ventral and closely associated with the legs and composed of two subsimilar foliaceous lobes. Second pair lateral, narrowing distalwards, directed outwards and downwards. Genital segment fused with trunk, abdomen short, distinct. Caudal rami with setae, apically drawn out into a spine. Egg tubes short.

Antennule two-jointed, basal segment much narrower than in *P. alatus*, with dorsal setae, second segment longer than broad, with a bunch of setae. Antenna very much like that of *P. alatus* but stouter and more strongly curved. Basal segment of maxilla squarish, distal with a distal inner serrated crest, apex bifid. Maxilliped three-segmented, basal segment large, third basally bulged, distally slender and spically curved.

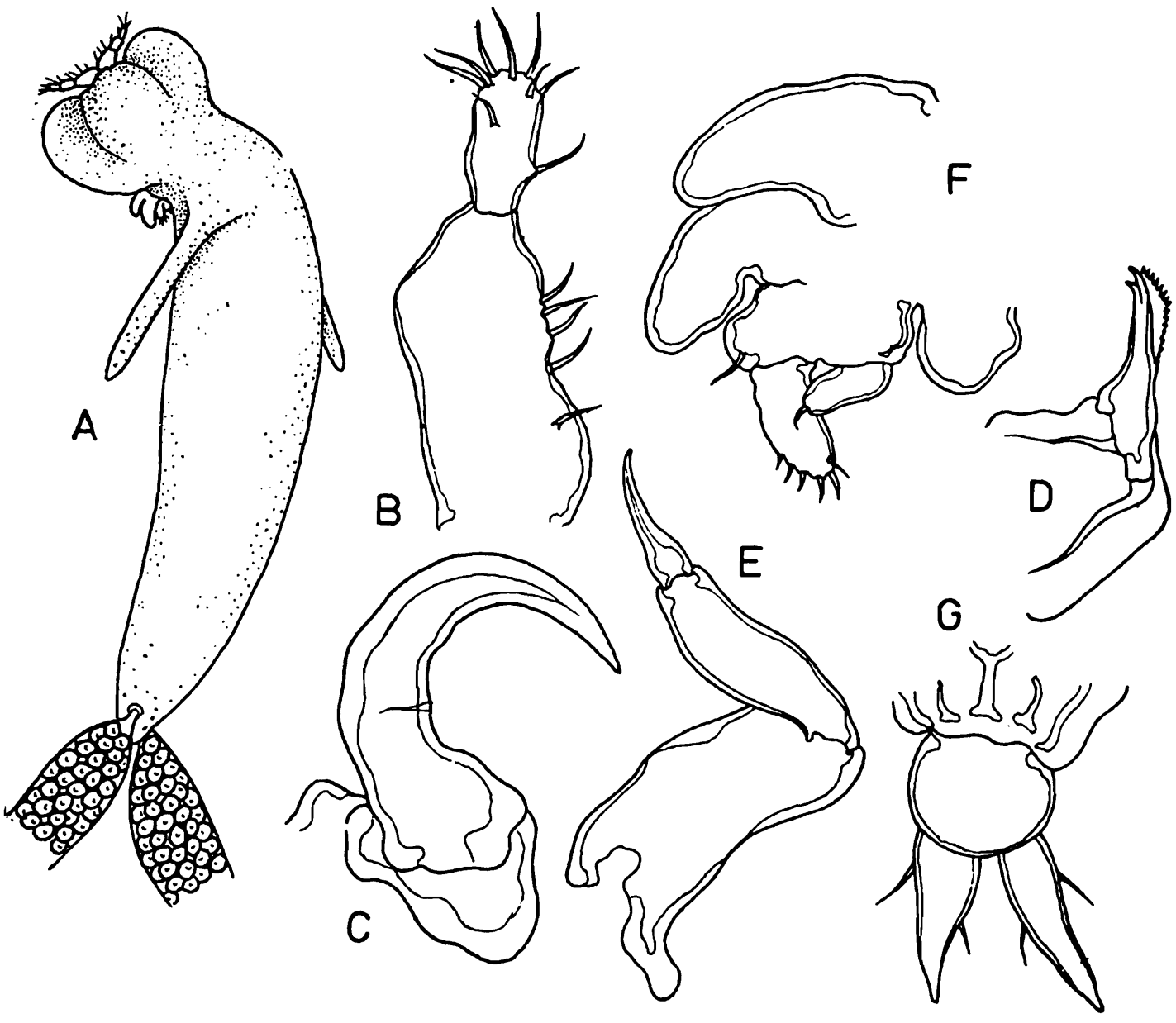


Fig. 34. A-G. *Protochondracanthus trilobatus* (Pillai) : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible ; E, maxilliped ; F, leg 1 and trunk process ; G, caudal rami.

First leg biramous, rami flattened and one-segmented. Basipod with an outer seta, exopod longer than endopod, with six setae, endopod directed outwards, with one apical seta.

*Length.*—3.4 mm.

*Host.—Psettodes erumei.*

*Distribution.*—India (Kerala).

*Holotype.*—female in the National Zoological Collection at Z.S.I., Calcutta.,Reg. No. C2113/2.

*Remarks.*—*P. trilobatus* is found along with *P. alatus* always, but in smaller numbers. They can be easily distinguished by the size and shape of the body. Of the two species, judging from the numbers, *P. alatus* is dominant.

## Genus **Heterochondria** Yu

*Heterochondria* Yu, 1935, p. 2 ; Ho, 1970a, p. 163.

*Diagnosis.*—Body long and cylindrical. Head large, longer than broad, with lateral swellings. Neck composed of first and second pedigerous segments, not much narrower than trunk. Third and fourth pedigerous segments fused into a cylindrical trunk. Trunk without processes. Genital segment fused with abdomen. Caudal rami of the usual type. Egg sacs cylindrical. Antennule thick and fleshy. Antenna uncinate. Oral appendages typically chondracanthid. Legs two pairs, both unilobed simple lamellae.

Type-species. : *H. longicephala* (Yu and Wu).

*Discussion.*—This genus resembles *Acanthochondria* and *Branchiochondrites* in the presence of unilobate legs but differs in the absence of body processes.

Ho (1970a) placed five species in this genus, namely, *H. similis* (Yu and Wu), *H. crassicornis* (Kroyer), *H. longicephala* (Yu and Wu), *H. longa* Tripathi and *H. pillaii* Ho. Only two of these have been recorded from Indian waters.

### *Key to species of* **Heterochondria**

1. Cephalon as long as broad, antenna with small blunt distal segment, second segment of maxilliped distally narrow ..... *.longa* Tripathi
— Cephalon clearly longer than broad, distal segment of antenna long and sickle-shaped, second segment of maxilliped distally expanded ..... *.pillaii* Ho

## **Heterochondria pillaii** Ho
(Fig. 35)

*Heterochondria pillaii* Ho, 1970a, p. 163, 187.
*Pseudochondracanthus longitruncus* Pillai, 1964b, p. 79, figs. 133-148 (nec Yamaguti, 1939c).

*Female.*—Head roughly rectangular, twice as long as broad, bulged at both ends making it remotely dumb bell-shaped. Anterior part with prominent dorsal ribs. Neck indistinct. Trunk long and cylindrical, about four times as long as head, postero-laterally rounded. Body processes absent. Genital segment and abdomen distinct, latter slightly smaller. Caudal rami constricted in the middle, distally drawn out, no setae. Egg tubes long.

Antennule two-segmented, basal segment highly flattened, without setae, second segment very small, setose. Antenna very long, two-jointed, basal joint small, distal sickle-shaped and projecting in front of the head, distal part of the claw transversely grooved. Labium a broad rectangular plate with spiny border. Mandible two-jointed, lower border of distal segment fully and upper border partially dentate. Maxilla two-jointed, distal segment with prominent basal lower spine and a spiny distal crest. Maxilliped three-jointed, second segment distally expanded, with a row of marginal spines, third segment a curved claw.

First leg an indistinctly two-jointed lobe with two minute apical spines. Second leg a simple lobe smaller than first.

*Length.*—3.0 mm.

*Male.*—General shape of body chondracanthid. Caudal rami large, with distinct partition, base with inner seta. Antennule similar to that of female. Antenna three-segmented and chelate. Mouth parts as in female but maxilliped slender, with straight third segment. Legs absent.

*Host.—Pseudorhombus arsius.*

*Distribution.*—India (Kerala).

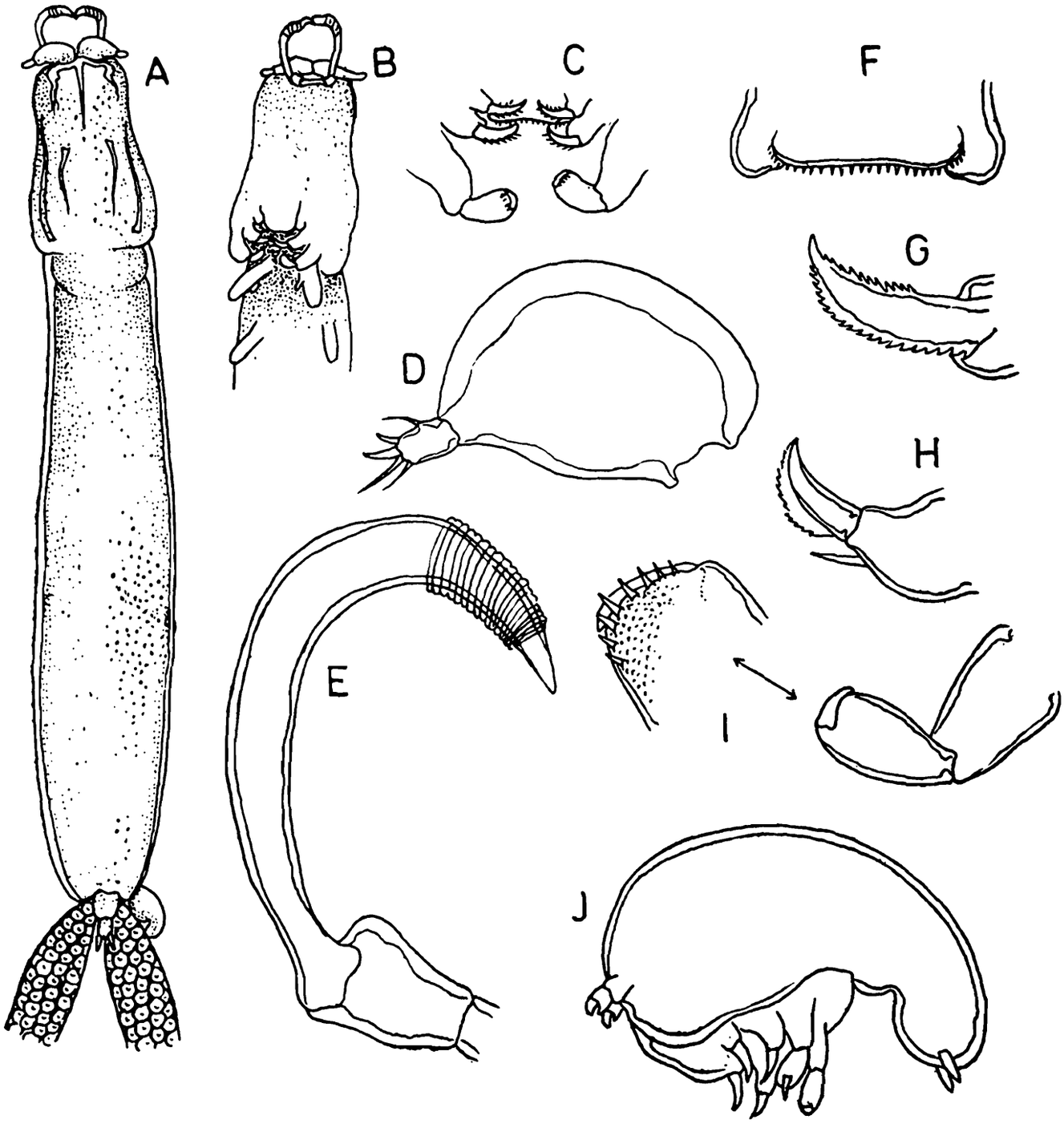


Fig. 35. A-J. *Heterochondria pillaii* Ho : A, female, dorsal view ; B, anterior part of body, ventral view ; C, oral appendages ; D, antennule ; E, antenna ; F, upper lip ; G, mandible ; H, maxilla ; I, maxilliped ; J, male, lateral View.

## **Heterochondria longa** Tripathi

*Heterochondria longa* Tripathi, 1960, p. 51, figs. 1-10 ; Ho, 1970a, p. 163.

*Female*.—Cephalon as long as broad, connected to trunk by a short neck. Trunk long, cylindrical, about four times as long as

cephalon. Genital segment longer than broad, narrowing. Abdomen short, indistinctly two-jointed ? Caudal rami as long as abdomen, tapering. Body processes absent.

Antennule biramous ?, distal segment with distal bunch of setae. Antenna two-jointed, second segment a short blunt claw. Upper lip with free border setose ? Mandible two-jointed, distal joint long and bilaterally toothed except for the upper distal part. Maxillule a small lobe with two small spines. Maxilla two-jointed, terminal segment ventrally barbed, dorsal distal part with two teeth, apex drawn out, basal segment carrying a small additional lobe with an apical spine. Maxilliped three-jointed, second segment enlarging distalwards, third segment a small curved claw, with an accessory process closing against the basal segment, latter with rows of fine hairs.

Legs two pairs, first situated at the hind end of cephalon, biramous ?, each ramus indistinctly two-jointed. Second pair uniramous and one-jointed.

*Length.*—1.9 mm.

*Male.*—Cephalothorax large, trunk unsegmented, caudal rami normal. Antennule one-jointed, antenna prehensile, subchelate, two-jointed. Mouth parts as in female, maxilliped distally not enlarged, claw straight. Legs absent.

*Length.*—0.3 mm.

*Host.*—*Pseudorhombus arsius, P. triocellatus.*

*Distribution.*—Orissa, Madras.

*Remarks.*—According to Ho *Heterochondria* is characterised by unilobate legs. In *H. longa* the first leg is biramous and each ramus is two-jointed. Hence Ho placed this species in *Heterochondria* with reservation.

In *H. pillaii* also there is a small inner lobe on the first leg which is visible only in certain positions. There is also a very indistinct

partition on the main lobe. If the character of the leg is crucial these two species will have to be taken out of *Heterochondria.*

## Genus **Ceratochondria** Yu

*Ceratochondria* Yu, 1935, p. 1 ; Ho, 1970a, p. 144.

*Diagnosis.*—Body long and cylindrical. Head not fused with any of the trunk segments, laterally forming rounded swellings. First thoracic segment forming a neck narrower than adjacent regions, with or without dorsal process, other segments fused into a trunk. Trunk processes absent. Genital segment and abdomen distinct, latter very small. Caudal rami with stout base. Egg sacs sausage-shaped. Antennule two-jointed, basal segment broad. Antenna bifid. Oral appendages of the usual form. First leg large, with small inner lobe, placed close to maxilliped. Second leg small, biramous, situated away from first.

Type-species. : *C. brevicollis* (Kroyer).

### **Ceratochondria hoi** sp. nov.
(Fig. 36)

*Pseudochondracanthus* sp. Pillai, 1964b, p. 81, figs. 149-150.

*Female.*—Body stout but short. Head with antero-lateral and postero-lateral regions swollen, constricted just behind the antero-lateral swellings. Dorsal side with three longitudinal ribs beginning from the base of the antennules. First thoracic segment short, indistinctly demarcated by a septum, forming a neck connecting cephalon and trunk. Trunk swollen, about four times as long as broad. Abdomen separated from trunk by a partition, distally bilobed.

Basal segment of antennule broad, without setae, distal segment short, with apical setae. Antennae broken off. Oral appendages typically chondracanthid. First leg placed close behind the maxillipeds, composed of an elliptic lamina with median inner lobe. Second leg placed far behind first, biramous, rami small, laminate, outer slightly larger.

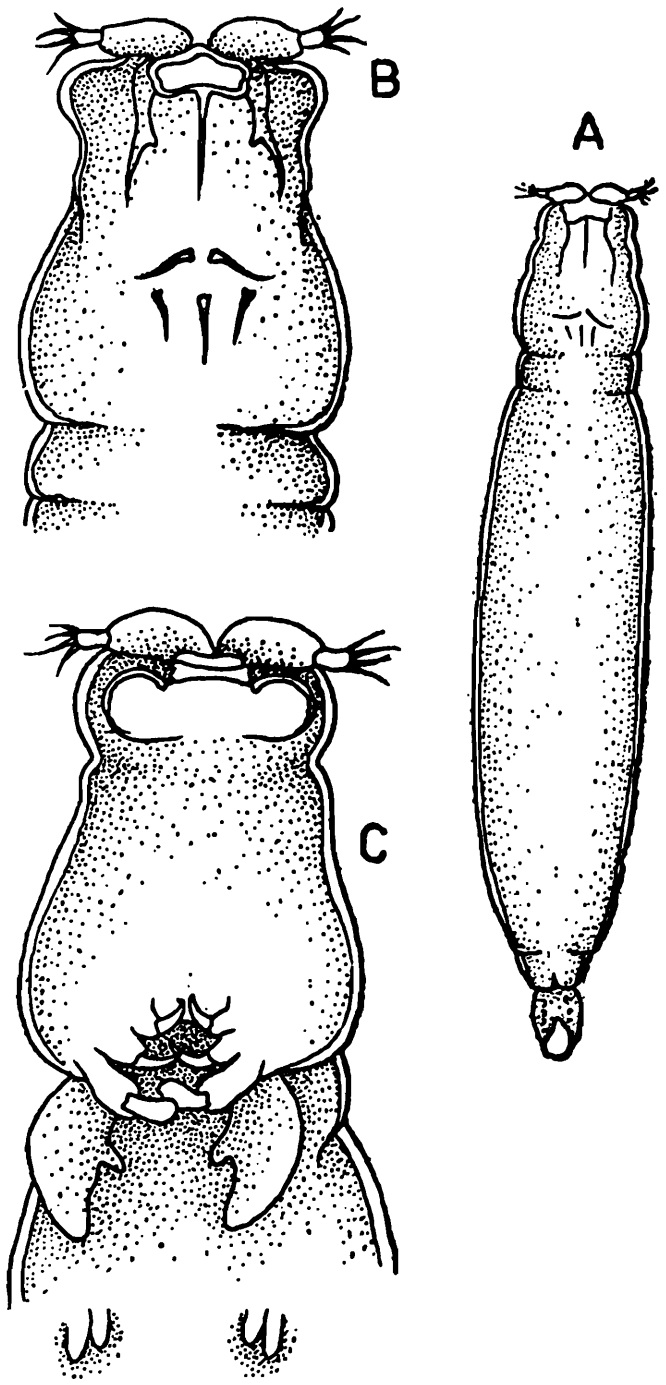


Fig. 36. A-C. *Ceratochondria hoi* sp. nov. : A, female, dorsal view : B, head, dorsal view ; C, same, ventral view.

*Length.*—2.1 mm.

*Host.*—*Plagusia* sp.

*Distribution.*—India (Kerala).

*Remarks.*—The identification of this species is provisional. I have only a single specimen and its antenna which provides one of the important generic characters is missing.

## Genus **Medesicaste** Kroyer

*Medesicaste* Kroyer, 1863, p. 312 ; Ho, 1970a, p. 178.

*Diagnosis.*—Cephalon very small, not fused with any of the trunk segments. Neck considerably elongated, with lateral expansions. Trunk small, but enlarged and dorso-ventrally flattened into an irregularly circular disc with posterior knobs and processes. Genito-abdomen of the chondracanthid type. Caudal rami unknown. Egg sacs cylindrical.

Antennule small, cylindrical. Antenna uncinate. Oral appendages chondracanthid. Leg one rudimentary, placed at anterior end of neck, others absent.

Male typically chondracanthid. Antennule and abdomen absent.

Type-species. : *M. triglarum* Kroyer.

*Discussion.*—Because of the extreme elongation of the neck this genus was placed by Leigh-Sharpe and Oakley (1927) in Lernaentominae. But recent study by Ho has shown that the oral appendages are placed immediately behind the antenna on the head itself and hence it should be included in Chondracanthinae.

### **Medesicaste penetrans** Heller

*Medesicaste penetrans* Heller, 1868, p. 235, pl. 25, figs, 1-4 ; Barnard, 1955, p. 300, fig. 31 ; Ho, 1970a, p. 180, figs, 205-208 ; Pillai, 1964b, p. 82, figs. 151-152.

*Female.*—Head very small. First and second trunk segments together forming a very long slender neck with a pair of alate expansions situated in the middle of the neck. Trunk disc-like and dorso-ventrally flattened, with a pair of anterior rounded lobes and a posterior pair of lobes slightly longer than the anterior. Anterior processes dorsal to insertion of neck, posterior ones clearly on the ventral side of the trunk. In the single specimen with me both processes overlap apically and there is a median genito-abdominal process and a pair of small additional processes over-

lapping the base of the egg sacs. Egg sacs short and cylindrical, unequal in length.

Antennule small and cylindrical, with a few small spines. Antenna chondracanthid, distal segment small and uncinate. Oral appendages chondracanthid. Legs one pair, situated on the head just behind the oral appendages.

*Length.*—28.0 mm.

*Host.*—*Trigla* sp., *T capensis.*

*Distribution.*—South Africa, India (Kerala).

## SUBORDER *CALIGOIDA*

*Diagnosis.*—Body varying in shape and segmentation, that of those living on the surface of the body of the host dorso-ventrally flattened, of those inhabiting gill filaments or permanently attached cylindrical. Body segmentation evident except in lernaeocerids. Legs generally present, usually biramous, rarely uniramous, often much reduced. Antenna or maxilliped or both prehensile. Oral appendages piercing and sucking type. Egg sacs slender, eggs uniseriate (except in *Pseudocongericola*).

*Discussion.*—This large suborder includes diverse types of forms but the presence of egg sacs with uniseriate eggs, with just one exception, is a common character. Except in the permanently fixed lernaeocerids which burrow deep into the body of the host some sort of segmentation of the body is always evident. Though the male may be small there is only limited sexual dimorphism in the appendages. The cephalothoracic appendages exhibit unmistakable relationship.

### *Key to families of CALIGOIDA*

1. Body more or less segmented, dorsoventrally flattened, fourth segment narrow, genital segment enlarged .2
— Body more or less segmented, usually cylindrical, fourth segment not narrowed, genital segment not enlarged .. .5

— Body long, cylindrical and vermiform, without segmentation ..... LERNAEOCERIDAE

2. First thoracic segment fused with cephalon ..... 3
— First and second thoracic segments fused with cephalon ..... TREBIIDAE

— First, second and third thoracic segments fused with cephalon ..... 4

3. Thoracic segments with dorsal plates ..... PANDARIDAE
— Thoracic segments without dorsal plates ..... DISSONIDAE

4. Fourth segment with dorsal plates ..... EURYPHORIDAE
— Fourth segment without dorsal plates ..... CALIGIDAE

5. First two pairs of legs normal, others lamelliform ..... ANTHOSOMATIDAE
— None of the legs lamelliform ..... 6

6. First two pairs of legs biramous, others reduced or setiform ..... 7
— First four pairs of legs normal and biramous ..... EUDACTYLINIDAE

7. First two pairs of legs with one-jointed spiny rami ..... PSEUDOCYCNIDAE
— First two pairs of legs with two-jointed setose rami ..... DICHELESTHIIDAE

## Family DISSONIDAE Yamaguti

*Diagnosis.*—First thoracic segment fused with cephalon, second, third and fourth free. Genital segment only moderately enlarged. Abdomen short, one or two-segmented. Caudal rami large, with large plumose setae. Cephalic appendages generally as in *Caligus*. Post-oral process large, carrying the maxillule. Legs one to four biramous, first with two-jointed rami, others with three-jointed rami.

Male generally like the female. Genital segment smaller.

Type-genus : **Dissonus** Wilson.

*Discussion.*—This family includes the single genus *Dissonus* containing nine species showing interspecific variation in many important characters. The sternal fork may be present or absent or replaced by what Kabata (1966a) described as 'sternal stylet' The genital segment may be armed or not with simple or forked spines on the ventral side. The host may be an elasmobranch or a teleost. Yet there is unusual uniformity in many important characters showing the homogenity of the genus.

## Genus **Dissonus** Wilson

*Dissonus* Wilson, 1906, p. 198 ; Yamaguti, 1963, p. 94 ; Kabata, 1966a, p. 211 ; Pillai, 1976, p. 40.
*Caligotrogus* Ummerkutty, 1970, p. 3.

*Diagnosis.*—First thoracic segment fused with cephalon forming a cephalothorax, broader than long. Second, third and fourth segments free, much broader than long, second often with side plates. Genital segment moderately enlarged, ventral side naked or armed with simple or forked spines. Abdomen short, one-or two-segmented. Caudal rami with stout setae. Egg tubes with a single row of eggs.

Antennule and antenna as in *Caligus*. Post-antennal process absent. Post-oral process large, carrying the maxillule. Maxilla and maxilliped as in *Caligus*. Sternal fork present or absent. Legs one to four biramous, first with two-jointed and others with three-jointed rami, spines on endopod segments not separated from the rami by partitions.

Male differing in size and shape of the genital segment. Antenna with accessory process on third segment.

Parasites of elasmobranchs and teleosts.

Type-species : *D. spinifer* Wilson.

*Key to species of* **Dissonus**

| | | |
|---|---|---|
| 1. | Sternal fork present | .*ruvetti* Nunes Ruivo and Fourmanoir |
| — | Sternal fork absent | .2 |
| 2. | Ventral side of genital segment with simple spines | .*spinifer* Wilson |
| — | Ventral side of genital segment with forked spines | .3 |
| 3. | Spines arranged in a semi-circle | .*furcatus* Kirtisinghe |
| — | Spines arranged in one transverse and two oblique rows | .*kapuri* (Ummerkutty) |

### **Dissonus kapuri** (Ummerkutty)
(Fig. 37)

*Caligotrogus kapuri* Ummerkutty, 1970, p. 3, figs. 1-14.
*Dissonus kapuri* Pillai, 1976, p. 37, figs. 1-12.

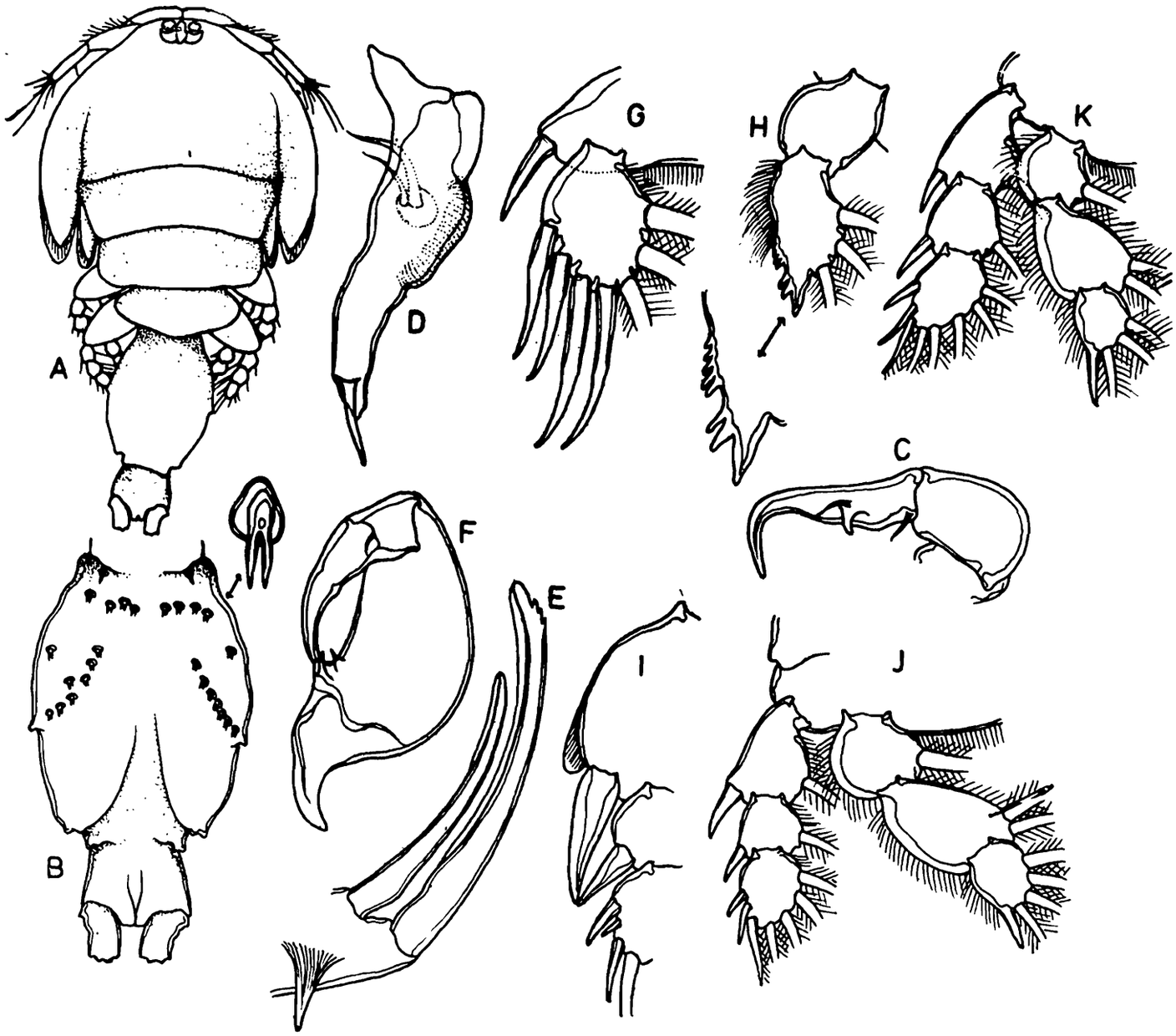


Fig. 37. A-K. *Dissonus kapuri* (Ummerkutty) : A, male, dorsal view ; B, genital segment and abdomen, ventral view ; C, antenna ; D, post-oral process ; E, maxilla ; F, maxilliped ; G, leg 1, exopod ; H, same, endopod ; I, leg 2, exopod ; J, leg 3 ; K, leg 4.

*Male.*—Cephalothorax much broader than long, postero-laterally produced into prominent lobes reaching the hind border of the second thoracic segment. Eyes antero-median, submarginal. Second thoracic segment short but broad, with distinct lateral plates. Third segment oblong, narrower than second. Fourth segment medially bulged. Genital segment elliptic, with median and posterior projections carrying the vestigial legs. Its ventral surface armed with a pair of proximal lateral simple spines, a pair of median lateral forked spines, a proximal transverse row of eight forked

spines and two longitudinal oblique rows of seven pairs of forked spines. Abdomen very short, one-segmented. Caudal rami with outer border curving inwards.

Distal segment of antennule with ventral plumose seta and a distal cluster of thirteen setae, two of them stout and long and one stout but short. Antenna with slender strongly curved distal segment, with two spines and an accessory claw. Post-oral process well developed, with median adhesion pad and a long subapical spine. Maxillule composed of a nodule on the post-oral process carrying two (three?) setae. Maxilla with long, strong, distal claws. Maxilliped robust, basal segment with step-like proximal inner projection followed by a tubercle carrying a spinule. Sternal fork replaced by a cylindrical, probably hollow process, the sternal stylet.

Rami of first leg two-jointed and greatly dissimilar, exopod large, basal segment long, distal short, with four spine-like setae. Inner border of distal segment of endopod proximally hairy and distally irregularly dentate. Second and third legs subsimilar, with three-segmented rami, third endopod segment with a strong spine, not separated from the segment by a septum. Fourth leg similar to third, legs progressively increasing in size so that the fourth is the longest.

*Length.*—2.0 mm.

*Host.*—Found free living on algae.

*Distribution.*—India (Dharwar).

### **Dissonus furcatus** Kirtisinghe

*Dissonus furcatus* Kirtisinghe, 1950, p. 77, figs. 5-12 ; 1964, p. 86, figs. 100-101
Yamaguti, 1963, p. 95.

*Female.*—Cephalothorax broader than long, dorsally demarcated into a median and two lateral areas, postero-lateral lobes triangular. Frontal plates confluent. Second thoracic segment transversely oblong, with distinct lateral plates, third segment

laterally produced, as broad and long as second segment. Fourth segment longer than third but narrower. Genital segment ovate, much longer than broad, its ventral surface with an arc of bifid spines confined to the anterior one third. Abdomen one-jointed, twice as long as broad. Caudal rami with large plumose setae.

Antennule two-jointed. Antenna two (three?)-jointed, third segment hook-like and armed with two spines. Post-oral process extending clearly beyond tip of mouth cone, carrying the maxillule consisting of a papilla with one long and two short setae, tip of the process with a long spine. Maxilliped stout, basal segment with proximal inner pad, distal segment strongly curved. Sternal fork absent.

First leg biramous, with two-jointed rami, endopod much smaller than exopod. Legs two to four with three-segmented rami. Fifth leg placed at the corners of the genital segment, a small papilla with four setae.

*Length.*—5.5 mm.

*Male.*—Body similar to that of female but more slender. Abdomen and caudal rami longer. The arc of spines occupies the anterior half of the genital segment. Distal segment of antenna with an accessory process.

*Length.*—4.5 mm.

*Host.*—Orectolobid shark.

*Distribution.*—Sri Lanka.

### **Dissonus spinifer** Wilson

*Dissonus spinifer* Wilson, 1906, p. 198, pl. 3, figs. 34-37 ; 1907a, p. 717, pl. 20. figs. 71-72 ; Yamaguti, 1963, p. 95, pl. 117, fig. 2.

*Female.*—Cephalothorax short, laterally expanded outwards and backwards into large lobes making it nearly twice as broad as long. Antero-median part slightly produced and squarely cut off.

Eyes far in front. Second, third and fourth thoracic segments much narrower than cephalothorax and successively narrowing. Genital segment roughly squarish, nearly as broad as fourth segment. Abdomen short, one-segmented, nearly twice as broad as long and postero-laterally slightly produced. Caudal rami as long as broad, immersed in the abdomen, with four large setae. Egg tubes as long as body, with large eggs.

Distal segment of antennule nearly as long as basal. Antenna with slender distal segment. Post-antennal process absent. Post-oral as usual, with long apical spine. Its base with broad lobe carrying three setae. Maxilla slender, sub-apical claw short. Basal segment of maxilliped stout, with inner median process, distal segment short and slightly curved.

Endopod of first leg short, two-jointed, distal segment with four spines and three setae. Basal segment of exopod large, inner border hairy, distal segment small, with three setae and four long spines. Rami of second leg three-jointed, first two exopod segments with one spine and one seta, third with three spines and five setae, first segment of endopod with one seta, second with two setae, third with four setae and one spine. Exopod of third leg with two spines and one seta on first segment, second segment with one spine and one seta, third with one spine and five setae, endopod segments with one, two and six setae respectively. First segment of exopod of fourth leg with one spine and one seta, second with one spine and one seta, third with three spines and five setae. Fifth leg a small papilla bearing three setae at the postero-lateral corner of the genital segment.

*Length.*—3.0 mm.

*Male.*—Body almost similar to that of female. Fourth segment comparatively longer. Genital segment elliptic, much longer than broad, its ventral surface fully covered with large sharp spines. Caudal rami longer than in female. Antenna stouter, third segment armed with a long sharp spine, a short blunt spine and a long slender seta.

*Length.*—3.0 mm.

*Host.—Tetrodon stellatus.*

*Distribution.*—Sri Lanka.

### **Dissonus ruvetti** Nunes Ruivo and Fourmanoir

*Dissonus ruvetti* Nunes Ruivo and Fourmanoir, 1956, p. 78, fig. 8 ; Yamaguti 1963, p. 95, pl. 117, fig. 1.

*Female.*—Cephalothorax nearly circular, with large postero-lateral lobes. Second thoracic segment small, its lateral plates large, filling the gap between the segment and the lobes of the cephalothorax. Third segment equal to second in length and width, fourth longer but narrower than second. Genital segment longer than broad, steadily broadening to the lateral projections at the posterior one third, further on narrowing to meet the abdomen. Ventral surface without spines. Abdomen two-segmented, first segment longer than second. Caudal rami with short setae.

Cephalic appendages as usual. Sternal fork present. Basipod of first leg with a long dorsal seta and short spine-like ventral seta. Basal segment of exopod with short outer spine, distal segment with four outer spines, two short, two long and three stout setae, endopod two-jointed and small, basal segment with one spine, distal with three setae. Legs two to four with three-segmented subequal rami.

*Length.*—4.0 mm.

*Male.*—Cephalothorax similar to that of female but posteriorly narrower. Thoracic segments subequal in length and width. Genital segment only slightly longer than broad, lateral borders evenly convex. Abdomen two-segmented, slightly broader than in female, first segment longer than second.

*Length.*—4.0 mm.

*Host.—Ruvettus pretiosus.*

*Distribution.*—Madagascar.

*Remarks.*—The specimens described were immature. But the presence of the sternal fork, the absence of spines on the ventral surface of the genital segment and the two-segmented abdomen distinguish this species from all the others.

## Family PANDARIDAE

*Diagnosis.*—First thoracic segment fused with cephalon forming a short but broad cephalothroax, postero-laterally expanded into large lobes. Segments two to four free, generally with dorsal plates. Genital segment large. Abdomen one- or two-segmented, terminal or ventral. Caudal rami lateral or terminal, normal or modified into chitinised processes.

Antennule two-jointed, basal segment with spine-like setae. Antenna three-segmented and prehensile, third segment generally with two weak spines. Maxillule a flat lobe placed near the base of the mouth tube. Maxilla two-jointed, distal segment with inner short and distal long claws, outer process variable. Maxilliped highly variable, basal segment often with adhesion pads, distal spatulate or dacyliform. Legs one to four biramous, conspicuously spiny, showing great modifications. Legs five and six much reduced.

Male without dorsal plates. Antenna and maxilliped slightly different. Legs one to four with two-jointed setose rami. Caudal rami with plumose setae.

Exclusively parasitic on elasmobranchs.

*Discussion.*—Pandarids are exclusively parasitic on elasmobranchs and their occasional presence on teleosts is purely accidental. They are generally found on the body surface, more commonly on the fins, on the gills and in the nasal passages or in the cloacal aperture. Those which live exposed are generally pigmented dark red.

The presence of rigid dorsal plates and the extreme chitinisation of the body has made the females incapable of moving about and are therefore permanently attached. At one time it was believed that the numerous adhesion pads on the ventral side and on the appendages help in securing a firm attachment but it is now known

that the main prehensile organ is the maxilliped. The pads and the large patches of spinules invariably associated with the legs must serve in preventing slipping. The sedentary habit has produced much modification and reduction of the legs. This has affected the first and fourth legs most. On the other hand the males which are capable of moving about have natatory legs.

As observed by Cressey pandarids show unusual stability in all the fundamental characters. Most of the variations are correlated with the ecology of the parasites. Those species which live exposed are deeply pigmented. Those which inhabit the gill filaments of the host show great reduction in the adhesion pads since they will be useless. On the other hand they have well developed prehensile antennae which give them a wice-like hold on the filaments. The maxilliped in these species has dactyliform distal segment. Those living on the surface of the body have a spatulate distal segment. In all pandarids the legs get modified into elytra-like structures. They must clearly assist in respiration for at least in a few instances there are well developed canals as in the pleopods of land isopods.

There was much confusion in the taxonomy of this family. Cressey revised it making considerable changes. Based on their morphology the genera were separated into two groups. The first group characterised by the presence of dorsal plates on segments two to four includes *Pandarus*, *Pseudopandarus*, *Perissopus*, *Phyllothereus*, *Gangliopus* and *Pannosus*, The second group is characterised by the presence of dorsal plates, when present, only on the fourth segment and includes *Dinemoura*, *Demoleus*, *Pagina*, *Echthrogaleus*, *Nesippus* and *Paranesippus*. Cressey further observed that in the first group the second segment of the maxilla has two spines or claws while in the second group there is one spine and a patch of spinules or setules. This distinction however is misleading since the patch of spinules is often placed on a process sometimes long and spine-like.

Cressey apparently recognised three segments in the maxilla (second maxilla). It is true that the apical claw shows a basal partition. But a similar partition is evident in caligids and allied families. For the sake of consistency I consider this appendage as two-jointed.

In the description of pandarids there is much variation regarding the presence or absence of dorsal plates. My study shows that Cressey is correct. Yamaguti largely followed Wilson.

Pandarids parasitic on oceanic sharks enjoy circum-tropical distribution. But till recently there were few records from the Indian ocean. Cressey helped me in the present study by sending all but three of the species described below.

*Key to genera of* PANDARIDAE

| | | |
|---|---|---|
| 1. | Dorsal plates present on segments two to four | .2 |
| — | Dorsal plates, if present, only on segment four | .6 |
| 2. | Dorsal plates of segment three extending beyond plates of segment two | .4 |
| — | Dorsal plates of segment three not extending beyond plates of segment two | .3 |
| 3. | Abdomen and caudal rami hidden in dorsal view | **Perissopus** Stp. & Lutk |
| — | Abdomen and caudal rami not hidden in dorsal view | **Pandarus** Leach |
| 4. | Plates of segment two small, overlapping those of segment three | .**Phyllothereus** Norman |
| — | Plates of segment two small, lateral to plates of segment three | .5 |
| 5. | Genital segment large, claw of maxilliped spatulate | **Pseudopandarus** Kirtisinghe |
| — | Genital segment small, claw of maxilliped dactyliform | **Gangliopus** Gerstaecker |
| 6. | Abdomen one-jointed | .7 |
| — | Abdomen two-jointed | .8 |
| 7. | Fourth leg lamelliform | **Echthrogaleus** Stp. & Lutk |
| — | Fourth leg not lamelliform | **Nesippus** Heller |
| 8. | Fourth leg lamelliform | .**Dinemoura** Latreille |
| — | Fourth leg not lamelliform | **Pagiua** Cressey |

## Genus **Pandarus** Leach

*Pandarus* Leach, 1816, p. 405 ; Wilson, 1907b, p. 387 ; Yamaguti, 1963, p. 110 ; Cressey, 1967a, p. 5.

*Diagnosis.*—Cephalothorax broader than long, postero-laterally produced into triangular lobes, the border between the lobes

usually dentate. Frontal plates large, separate. Second thoracic segment with a pair of large dorsal plates generally inclined outwards. Third segment with a pair of plates generally fused together and not reaching beyond plates of fourth segment, latter similar to those of third. Genital segment postero-laterally produced into lobes enclosing between them the median lobe. Abdomen one-or two-segmented, covered by the median lobe. Caudal rami chitinised processes attached laterally to the abdomen, directed outwards and backwards.

Basal segment of antennule with spine-like setae. Middle segment of antenna with a projecting pad. Maxilla with three processes. Distal segment of maxilliped spatulate. Rami of leg one indistinctly two-jointed, of second leg two-jointed, of third and fourth laminate, former two and latter one-jointed.

Male with shorter cephalothorax. Genital segment with large lateral lobes carrying the fifth and sixth legs. Abdomen two-jointed. Caudal rami flat, with long setae. Distal segment of maxilliped dactyliform. Legs one to four with two-jointed setose rami.

Type-species : *P. bicolor* Leach.

*Discussion.*—According to Cressey (1967a) of the twenty nine species so far described only ten are valid.

In the definition of the genus reference is often made to a dorsal plate covering the abdomen. Wilson designated this as the sixth segment. But the sixth leg or what is considered as the sixth leg is far in front on the genital segment. Reference is also made to a ventral abdominal plate. Cressey makes no mention of this and I could not find any.

*Key to species of* **Pandarus**

1. Dorsal plates of second segment reaching or slightly overreaching hind border of plates of segment three . . .2
—Dorsal plates of second segment clearly overreaching plates of segment three .. . .3

2. Plates of second segment not reaching hind border of plates of third segment, plates of segment four with small median sinus .*niger* Kirtisinghe
— Plates of second segment slightly over-reaching plates of third segment, plates of segment four with deep median sinus *carcharini* Ho
3. Caudal rami basally very broad *smithii* Rathbun
— Caudal rami basally not very broad .4
4. Caudal rami not reaching tip of abdominal plate *satyrus* Dana
— Caudal rami reaching or overreaching abdominal plate *cranchii* Leach

## **Pandarus niger** Kirtisinghe
(Fig. 38)

*Pandarus niger* Kirtisinghe, 1950, p. 83, figs. 13-22 ; 1964, p. 83, figs. 97-98 ; Yamaguti, 1963, p. 112 ; Cressey, 1967a, p. 22, figs. 109-118 ; Rangnekar and Rangnekar, 1972, p. 72, pl. 1.

*Female.*—Cephalothorax triangular, regularly widening backwards, postero-lateral lobes not at all prominent, posterior border irregular, with five pairs of tubercles, each carrying a spinule. Frontal plates prominent and projecting. Dorsal plates of second thoracic segment small, rounded and longitudinally oriented, not reaching the distal border of the plates of the third segment but slightly overlapping the latter. Plates of third segment partially fused, with deep median sinus. Plates of fourth segment fully fused, with irregular hind border, with small median sinus. Genital segment narrowing beyond the dorsal plates of fourth segment, postero-laterally produced into broadly triangular lobes. Abdominal plate broadening backwards. Caudal rami very long, steadily narrowing, distally slightly incurved, with three spines and two setae.

Antennule and antenna associated with large adhesion pads. Basal segment of antenna short, second with large projecting outer pad, third irregular and stumpy, with the two usual spines. Maxillule with two proximal setae and a stout distal process with serrate edge. Basal segment of maxilla stout, distal slender, with short outer process and normal inner and median processes. Basal segment of maxilliped strongly produced inwards and with a pad against which the distal spatulate segment closes, latter with long spine.

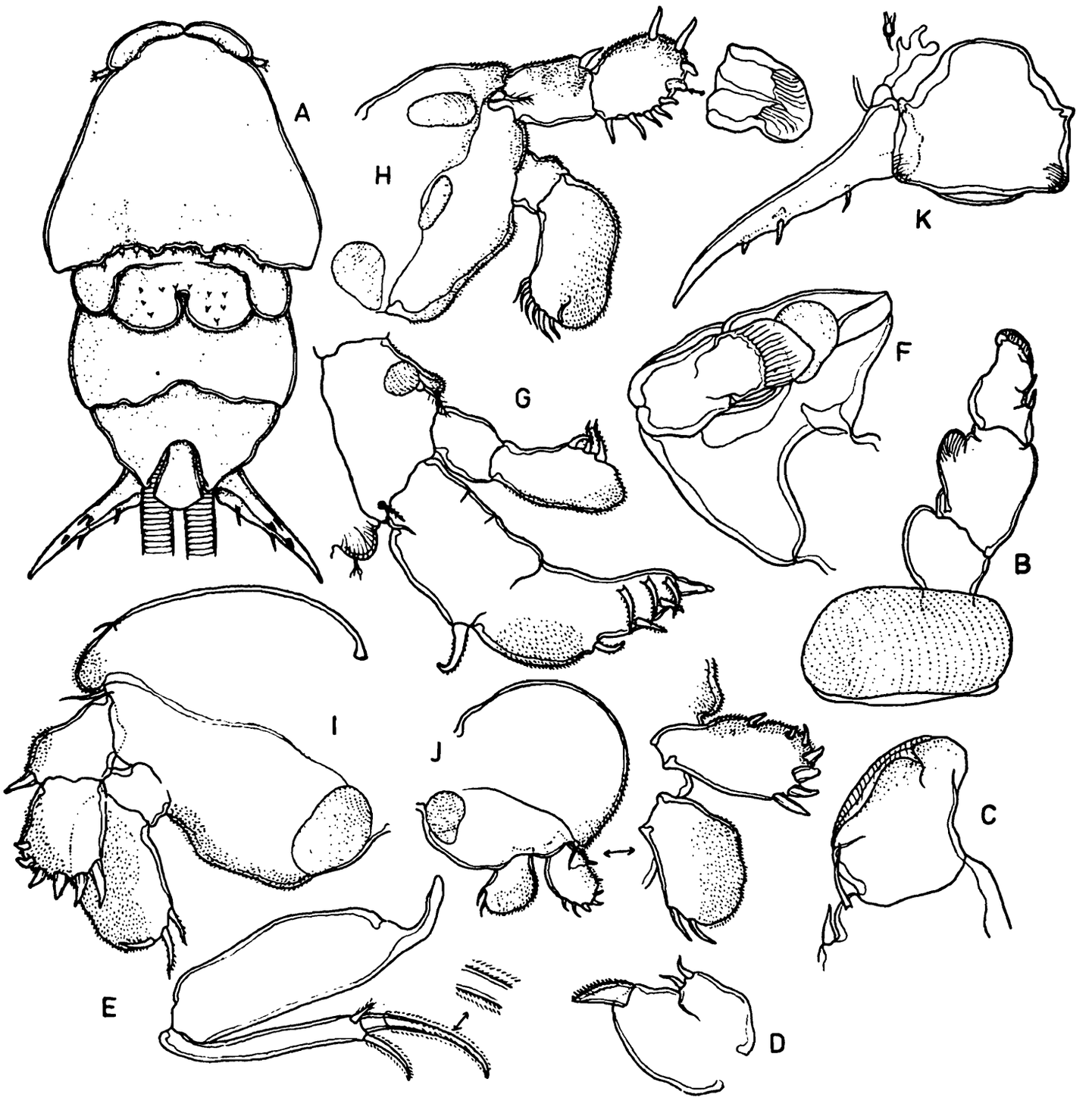


Fig. 38. A-K. *Pandarus niger* Kirtisinghe : A, female, dorsal view ; B, antenna ; C, same, tip enlarged ; D, maxillule ; E, maxilla ; F, maxilliped ; G-J, legs 1-4 ; K, leg 5, abdomen and caudal ramus.

Basipod of first leg with two pads, endopod two-jointed, distal segment with three pectinate setae, exopod comparatively stout, indistinctly two-jointed, with four outer curved claws, three inner pectinate spines and one distal stout process. Basipod of second leg with three pads, rami two-jointed, distal exopod segment with

nine claws, one of them stout and blunt, distal endopod segment with seven spine-like setae. Basipod of third leg enlarged, with one pad, distal exopod segment with six claws, distal endopod segment with three spines. Basipod of fourth leg rounded, with one pad, rami subsimilar, one-jointed, exopod with seven and endopod with two spines.

*Length.*—8.0 mm.

*Host.*—*Galeorhinus* sp., *Carcharhinus* sp.

*Distribution.*—Indian Ocean (Sri Lanka, Bombay), Pacific Ocean (Formosa).

*Remarks.*—Cressey illustrated the female without median sinus on the dorsal plate of the third thoracic segment and with a small sinus on the fourth. In the specimen I studied both plates have a more prominent sinus, more or less as shown by Kirtisinghe. The plates of the second segment are not fused with those of third as shown by Cressey. As the median sinus of the fourth plate is fairly prominent this character cannot be used for distinguishing this species from *P. carcharini* Ho.

The illustrations of this species published by Kirtisinghe lack details and those of Rangnekar and Rangnekar are faulty. I have therefore fully illustrated this species.

## **Pandarus carcharini** Ho
(Fig. 39E, 40)

*Pandarus carcharini* Ho, 1963, p. 93, figs. 13-22 ; Cressey, 1967a, p. 23, figs. 119-124.

*Female.*—Cephalothorax triangular, regularly widening backwards, postero-lateral lobes short and rounded, posterior border evenly concave, with five pairs of spines mounted on tubercles. Frontal plates projecting. Dorsal plates of second thoracic segment small, longitudinally oriented, not reaching tip of succeeding plates. Plates of third segment fused, overlapped by the plates of the second segment. Plates of fourth segment fully fused, with moderately

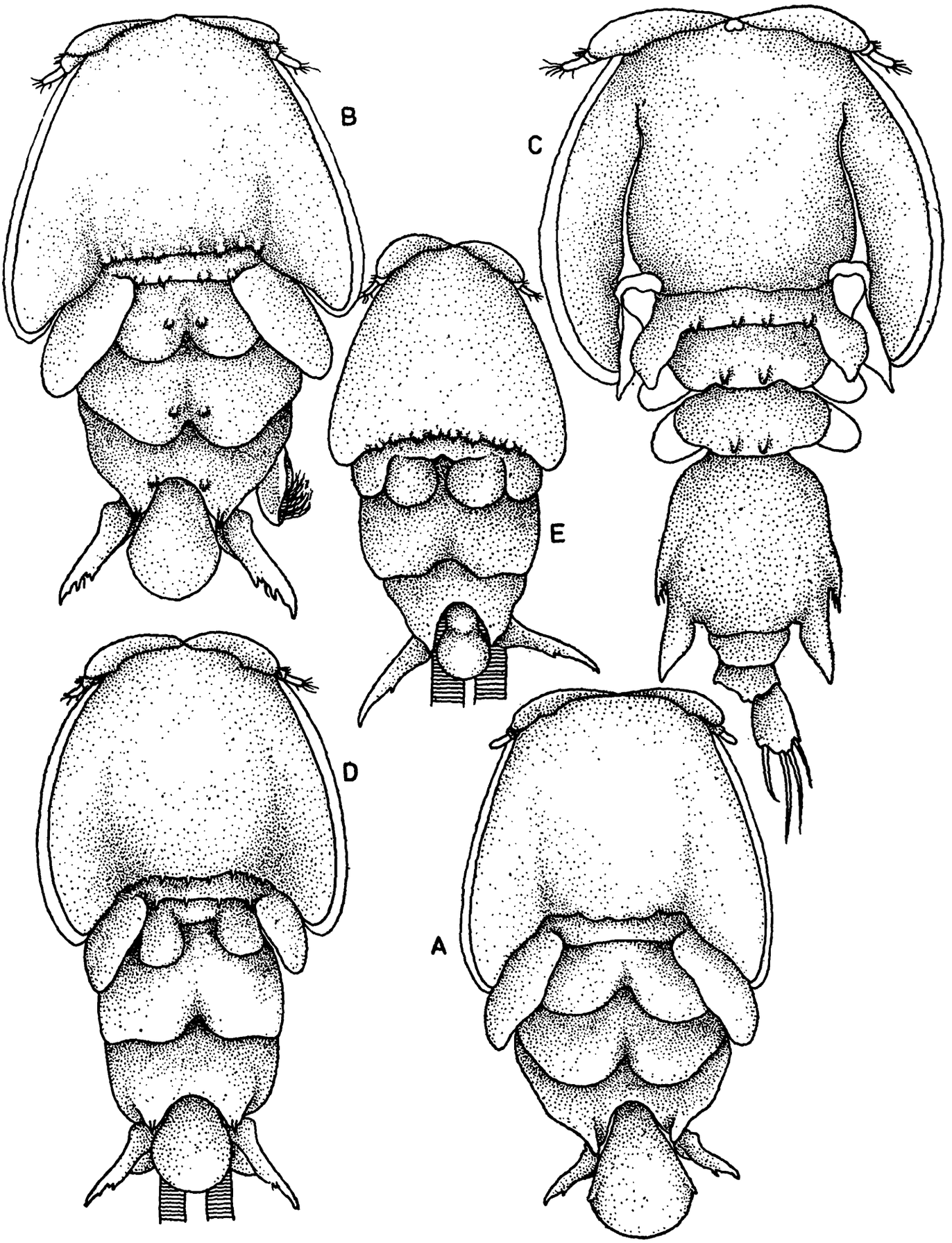


Fig. 39. A, *Pandarus satyrus* Dana, female, dorsal view ; B, *Pandarus Cranchii* Leach, female, dorsal view ; C, same, male, dorsal view ; D, *Pandarus smithii* Rathbun, female, dorsal view ; E, *Pandarus carcharini* Ho, female, dorsal view.

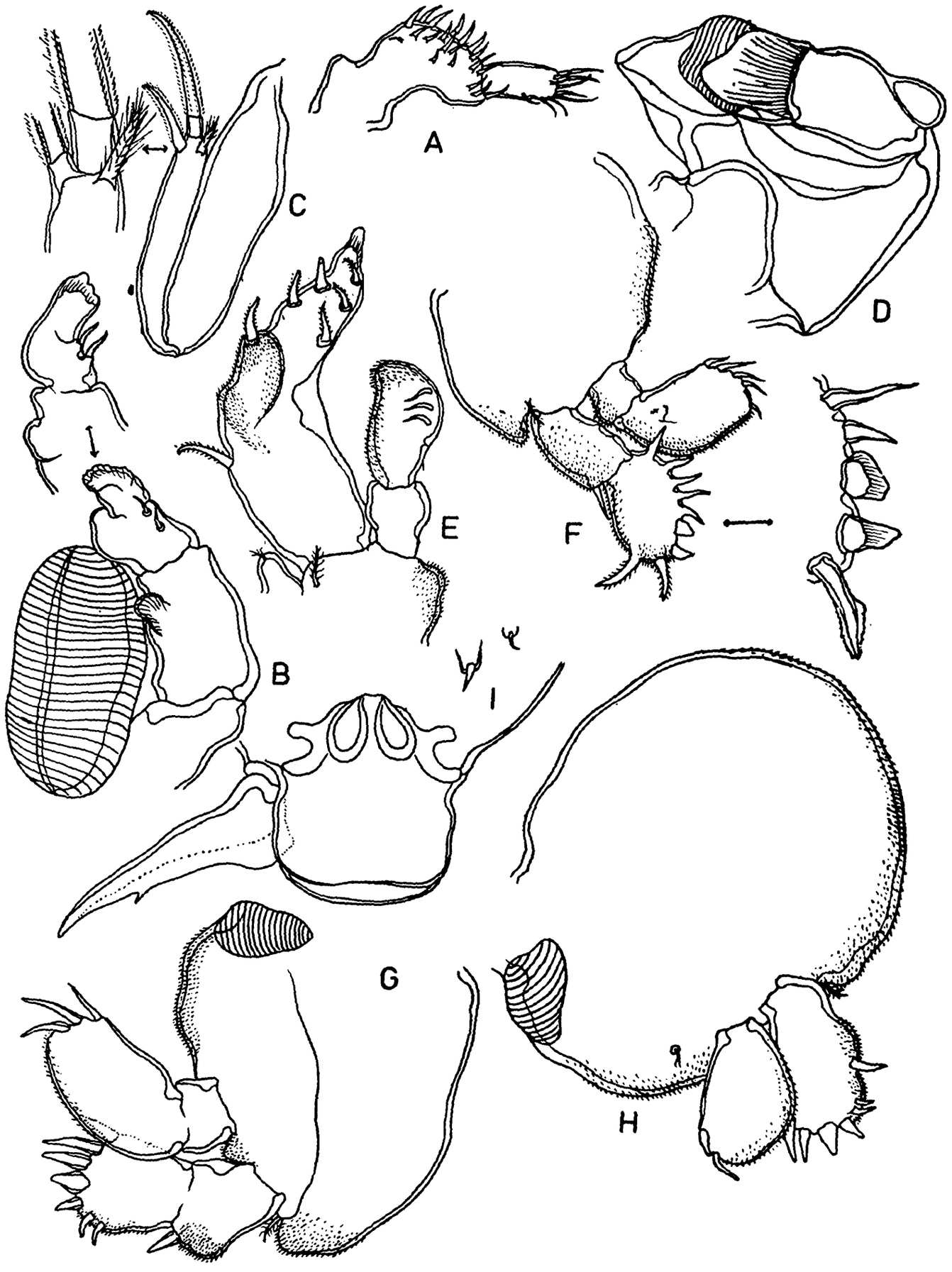


Fig. 40. A-I. *Pandarus carcharini* Ho ; A, antennule ; B, antenna ; C, maxilla ; D, maxilliped ; E-H, legs 1-4 ; I, legs 5 and 6, abdomen and caudal ramus.

deep postero-median sinus. Genital segment narrowing. Abdominal plate large, with indistinct transverse groove. Caudal rami long and slender, with two spines. Dorsal side of body with scattered transparent spots, each carrying one or more hairs.

Basal segment of antennule somewhat twisted, with fairly long setae. Antenna asssociated with a large pad, first segment short, second longest, with outer small pad, third segment irregular, with two spines, tip irregular and grooved. Maxilla with basal segment longer than distal, latter slender, with the usual armature. Basal segment of maxilliped with prominent pad, distal segment spatulate, with a long spine.

Basipod of first leg without pad, endopod two-jointed, distal segment with three spines, exopod comparatively stout, one-jointed, with four outer, three inner and one stout blunt distal claws. Second leg with two-jointed rami, distal exopod segment with nine spines, two of them blunt, distal endopod segment with six spines, basipod without pad. Basipod of third leg with an indistinct pad, rami indistinctly two-jointed, distal exopod segment with seven stout spines, distal endopod segment with three slender spines. Basipod of fourth leg large, roughly circular, with one pad, rami one-jointed, endopod with two and exopod with seven stout claws.

*Length.*—9.8 mm.

*Host.*—*Galeorhinus* sp., *Carcharhinus gangeticus*, *C. leucas*, *C. sorrah*, *C. limbatus*.

*Distribution.*—Pacific ocean (Formosa), Indian ocean (Madagascar), South Africa.

*Remarks.*—As observed by previous workers this species closely resembles *P. niger* Kirtisinghe. However my study has shown that the postero-lateral lobes of the cephalothorax are better developed in *P. carcharini*, caudal rami comparatively longer in *P. niger* and the abdominal plate with a transverse groove in *P. carcharini*. The most useful differences are to be found in the armature of the legs. Generally the claws and spines on the legs of *P. carcharini* are stouter.

On comparing with the description given by Cressey the second thoracic segment is clearly visible and its dorsal plates are shorter, Similarly the median sinus of the fourth plate is broader but shallower. Cressey has shown distinct segmentation in the rami of the legs. In my specimen segmentation is indistinct. The comparative size of the rami of the fourth leg is different from mine.

**Pandarus satyrus** Dana
(Fig. 39A, 41 A-I)

*Pandarus satyrus* Dana, 1852, p. 1368, pl. 95, figs. 2a-c ; Wilson, 1907b, p. 415, pl. 31, figs. 162-171 ; Yamaguti, 1936c, p. 5, pl. 3, fig. 36, pl. 4, figs. 37-41 ; Shiino, 1954d, p. 312, figs. 11-17 ; Lewis, 1966b, p. 74, figs. 7-9 ; Cressey, 1967a, p. 6, figs. 1-26.

*Female.*—Cephalothorax gradually broadening backwards, postero-lateral lobes fairly large, reaching beyond the middle of the dorsal plates of the second segment, posterior border medially produced, without spines, frontal border rather broad, frontal plates comparatively small. Dorsal plates of second thoracic segment elongate oblong, inclined outwards and over-reaching the dorsal plates of the third segment. Latter fully fused, with broad median sinus. Dorsal plates of fourth segment larger than those of third, with narrow median incision. Genital segment postero-laterally produced into small conical lobes, median sinus with even border. Abdominal plate large, regularly broadening to a pair of lateral spine-like projections, rounded beyond, lateral borders straight. Abdomen an irregular plate. Caudal rami short, in the normal position not reaching beyond the lateral spines of abdominal plate.

Second segment of antenna stout, with prominent bilobed outer pad, third segment short, with two spines, inner border near apex irregular. Maxillule with three outer setae, inner distal short spine and stout distal claw. Maxilla with strong inner and distal processes, outer short, apically drawn out and pectinate. Basal segment of maxilliped with a projecting pad, distal spatulate, apically bilobed, with a spine and a proximal bulge.

Basipod of first leg with a pad and three spiny lobes, rami two-jointed, basal endopod segment with a pad, distal large, with three

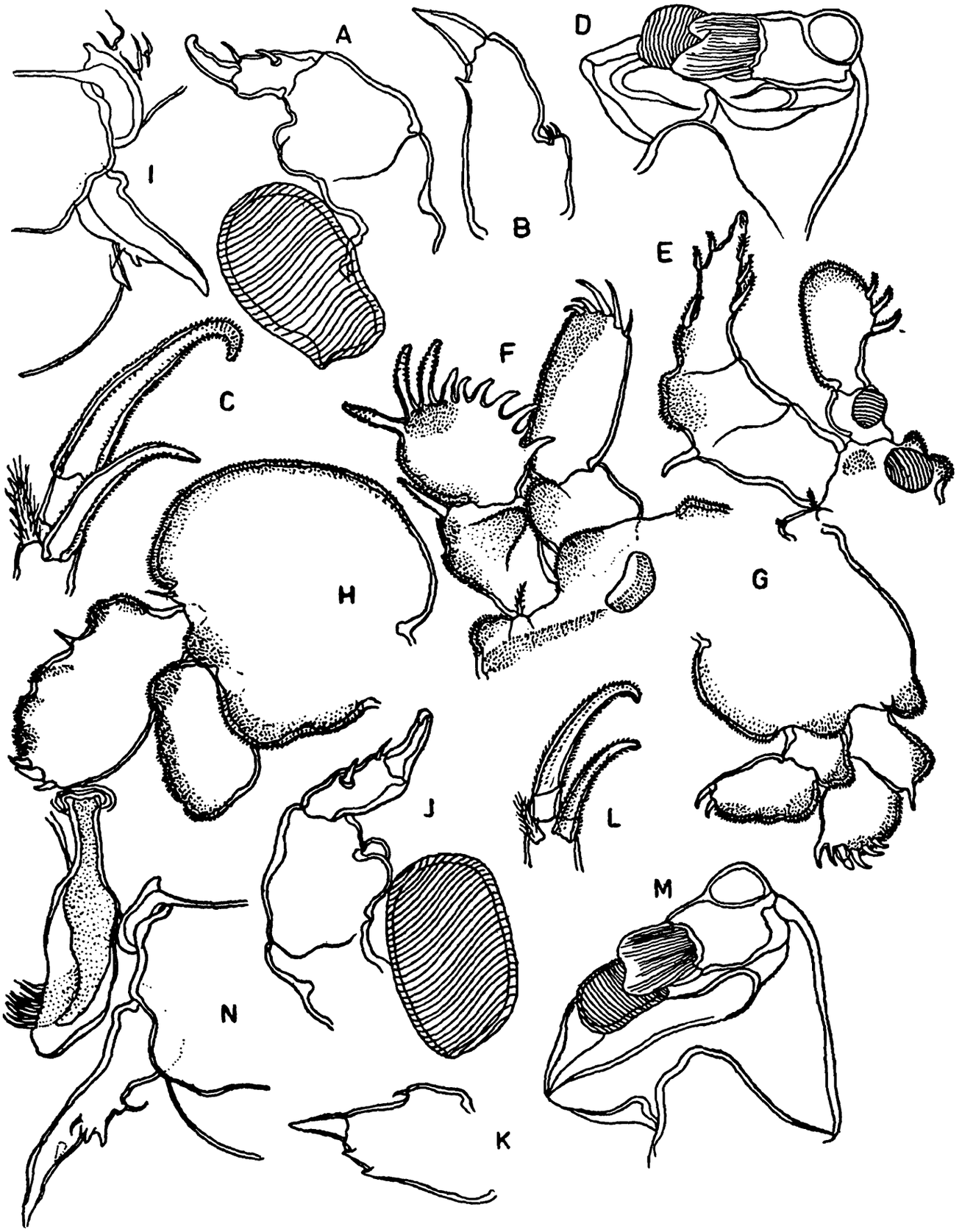


Fig. 41. A-I. *Pandarus satyrus* Dana : A, antenna ; B, maxillule ; C, maxilla. D, maxilliped ; E-H, legs 1-4 ; I, legs 5 and 6, abdomen and caudal ramus ; J-N. *Pandarus cranchii* Leach : J, antenna ; K, maxillule ; L, maxilla ; M, maxilliped ; N, abdomen and caudal ramus.

claws, exopod with weak spines. Basipod of second leg with several patches of denticles, exopod broader than endopod, with strong, long pectinate blunt spines and short claws, distal endopod segment with long spines. Third leg with subequal rami, distal segment of exopod with six claws, one of them blunt, distal segment of endopod with two claws. Exopod of fourth leg much larger than endopod, with one outer and five distal claws, endopod without claws.

*Length.*—8.2 mm.

*Host.—Prionace glauca, Sphyrna zygaena, S. diplana.*

*Distribution.*—Cosmopolitan.

**Pandarus cranchii** Leach
(Fig. 39B-C, 41J-N, 42)

*Pandarus cranchii* Leach, 1819, p. 535 ; Stp. & Lutk., 1861, p. 390, pl. 11, fig. 22 ; Wilson, 1907b, p. 403, pl. 28 ; 1935a, p. 333, pl. 5, figs. 58-70, pl. 6, fig. 71 ; Heegaard, 1943b, p. 27, figs. 76-78 ; Lewis, 1966b, p. 81, figs. 10-13 ; Cressey, 1967a, p. 9, figs. 27-33.

*Female.*—Cephalothorax prominently broadening backwards, postero-lateral lobes large, reaching the middle of the dorsal plates of the second thoracic segment, posterior border with four pairs of tubercles, each carrying a spinule. Frontal border rather wide, frontal plates not projecting. Hind border of second thoracic segment with two pairs of spines, its dorsal plates elongate oblong and oblique. Dorsal plates of third thoracic segment comparatively small, fused together, with narrow median sinus and a pair of spines just above the sinus. Plates of fourth segment large, fused, with fairly wide sinus and a pair of spines as in the third plates. Genital segment with large postero-larteral lobes with two pairs of spines. Abdominal plate with straight lateral borders as in *P. satyrus* but not ending in projections. Caudal rami reaching bevond the abdominal plate.

Second segment of antenna with a double outer pad, third segment with two strong spines, apex recurved. Maxillule with one outer seta, two inner distal spines and a stout distal process. Distal segment of maxilla with comparatively short inner and distal

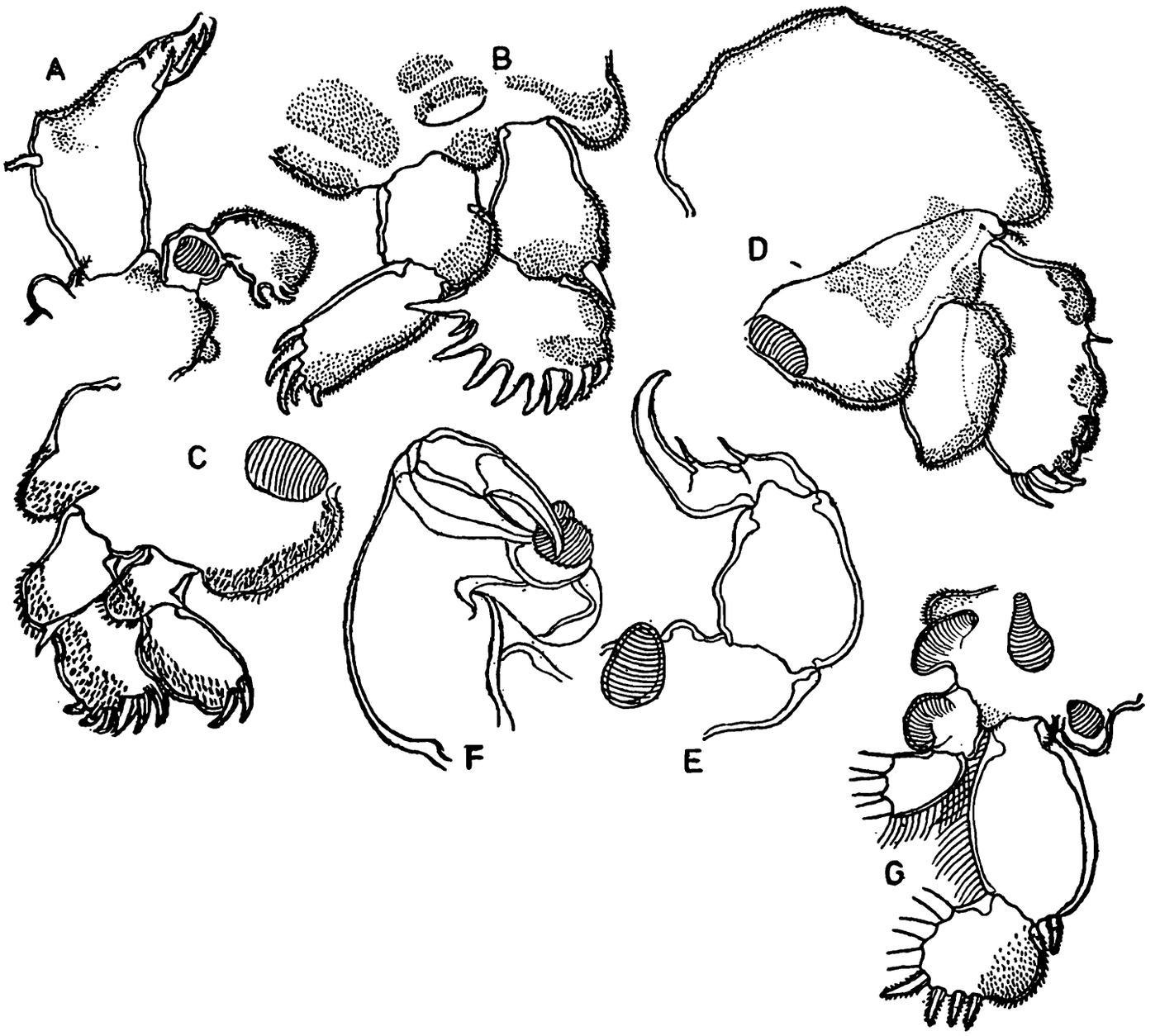


Fig. 42. *Pandarus cranchii* (contd.) ; A-D, female, legs 1-4 ; E-G, male ; E, antenna ; F, maxilliped ; G, leg 1.

processes, outer process as in *P. satyrus*. Maxilliped as in *P. satyrus*.

Basipod of first leg with four spiny lobes, basal segment of endopod with a pad, distal with three claws, exopod with small claws and spines, apex claw-like and recurved. Basipod of second leg with several spiny pads, distal segment of exopod very broad, with ten strong claws, one of them very small, distal endopod segment narrow, with five claws. Distal exopod segment of third leg with six claws, distal endopod segment with two. Exopod of

fourth leg longer than endopod, with one outer and six distal claws, endopod without claws.

*Length.*—8.4 mm.

*Male.*—Cephalothorax comparatively broader, frontal plates projecting, hind border without spines. Second thoracic segment with two pairs of teeth, laterally expanded into large lobes, third and fourth segments transversely oblong, without lobes, each with a pair of teeth. Genital segment as long as broad, postero-laterally produced into a pair of large apically acute lobes almost reaching the tip of the abdomen.

Basal segment of antenna with a pad, second segment without pad. Basal segment of maxilliped internally bulging, with two corrugated pads, distal segment dactyliform. Basipod of first leg with three projecting pads, basal segment of endopod with one pad, exopod much larger than endopod.

*Length.*—10.4 mm.

*Host.—Pterolamiops longimanus, Eulamia falciformis, E. obscurus, E. floridanus, Carcharhinus malpeloensis, Sphyrna zygaena, Galeocerdo cuvier, Carcharhinus obscurus, C. brachyurus, Lamna nasus, Sphyrna lewini.*

*Distribution.*—Cosmopolitan.

*Remarks.—P. satyrus* and *P. cranchii* have been synonomised by Shiino but Lewis and Cressey considered them as different. Lewis observed that in *P. cranchii* the caudal rami are longer, the lobe on the middle segment of the antenna is single lobed (bilobed in *P. satyrus*), post-oral process or maxillule is one-segmented (three-jointed in *P. satyrus*), distal segment of the maxilla has a clump of plumosities (absent in *P. satyrus*) and the armature of the legs is different. On the other hand Cressey distinguishes the two species by the difference in the length of the caudal rami which overreach the abdominal plate in *P. cranchii* but are much shorter in *P. satyrus*.

I could examine only a single female of each of these species. Based on this study the following characters seem to separate them. As observed by Cressey the caudal rami are different. In *P. satyrus* the abdominal plate has two lateral processes. Dorsal side of the body of *P. cranchii* carries prominent spines which are absent in *P. satyrus*. The claws and spines on the legs of *P. cranchii* are stouter than those of *P. satyrus*. The difference observed by Lewis in the antenna, post-oral process and maxilla do not actually exist.

## **Pandarus smithii** Rathbun
(Fig. 39D, 43)

*Pandarus smithii* Rathbun, 1886, p. 315, pl. 5, fig. 3, pl. 7, fig. 9 ; Wilson, 1907b, p. 410, pls. 29-30 ; Shiino, 1959c, p. 353, fig. 8 ; Lewis, 1966b, p. 91, figs. 14-16 ; Cressey, 1967a, p. 11, figs. 34-35.

*Female.*—Cephalothorax somewhat rounded, postero-lateral lobes curving inwards, frontal border rather broad, posterior border with four pairs of fairly stout spines. Frontal plates prominently projecting. Second thoracic segment with two pairs of large spines, its dorsal plates oblong, slanting and reaching far beyond the plates of the third segment. Latter small, situated wide apart. Plates of fourth segment fused, with fairly deep postero-median sinus. Genital segment not narrowing backwards, with a pair of posterior lobes carrying a spine. Abdominal plate nearly circular. Caudal rami basally highly flattened.

Antenna associated with a very large pad, second segment with a projecting pad, third segment apically subtruncate. Maxillule comparatively narrow, with one outer proximal and one inner distal spine, apical process moderately stout. Maxilla and maxilliped as in *P. satyrus* and *P. cranchii.*

Basipod of first leg with prominent, projecting spiny lobes and a pad, basal segment of endopod with a pad, distal with a characteristic irregularity, exopod rather slender. Basipod of second leg with a projecting pad and prominent spiny lobes, distal exopod segment with ten short claws, distal endopod segment with four claws. Basipod of third leg produced into a large ventral lobe, rami short, exopod one-segmented, endopod two-segmented, both

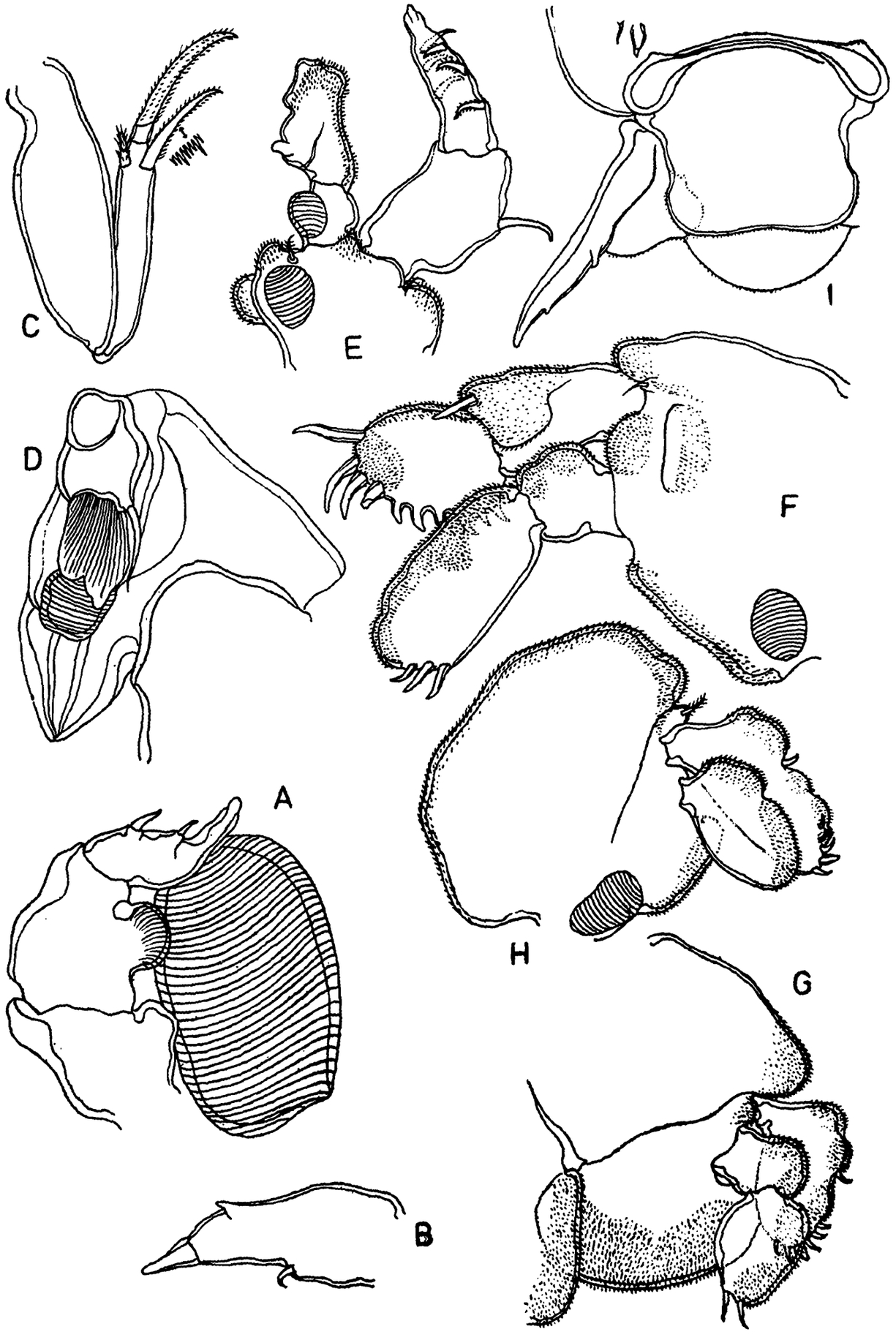


Fig. 43. A-I. *Pandarus smithii* Rathbun ; A, antenna ; B, maxillule ; C, maxilla ; D, maxilliped ; E-H, legs 1-4 ; I, legs 5-6, abdomen and caudal ramus.

with short claws and spines. Basipod of fourth leg with small ventral lobe, rami one-jointed, exopod longer.

*Length.*—8.2 mm.

*Host.*—*Isurus oxyrhynchus*, *Eulamia obscurus*, *E. floridanus*, *Alopias vulpinus*, *Carcharhinus azureus*, *C. galapagensis*, *C. malpeloensis*, *C. limbatus*, *Hypoprion signatus*, *Carcharodon carcharias*, *Sphyrna zygaena*, *Carcharhinus milberti*, *C. obscurus*, *Carcharias taurus*.

*Distribution.*—Cosmopolitan.

*Remarks.*—This species can be distinguished from the others described in this work by the widely separated plates of the second thoracic segment, equally broad genital segment, nearly circular abdominal plate, basally broad caudal rami and the absence of segmentation in the exopod of the third leg.

My specimen is similar to that described by Lewis but differs from those of Cressey in some details. Cressey has shown the dorsal plates of the fourth segment as broader than the genital segment, not so in mine. The genital segment has posterior porcesses bearing a spine. This has not been shown by Cressey.

## Genus **Pseudopandarus** Kirtisinghe

*Pseudopandarus* Kirtisinghe, 1950, p. 84 ; Yamaguti, 1963, p. 128 ; Pillai, 1964b, p. 65 ; Cressey, 1967a, p. 29.

*Diagnosis.*—Cephalothorax comparatively small, posterolaterally produced into small triangular lobes. Frontal plates separate. Dorsal plates of second thoracic segment small, lateral and wide apart, plates of segment three fused, with postero-median sinus, plates of segment four similar to those of third but larger. Genital segment about half the total length of the animal. Abdomen indistinctly two-jointed, attached to ventral side of genital segment, covered by dorsal plate. Caudal rami terminal, laminate, with plumose setae.

Antennule and antenna associated with large pads. Distal segment of maxilla with three processes. Basal segment of maxilliped with distal adhesion pad, claw spatulate. Rami of legs one to three two-jointed, of fourth one-jointed. Basipod of leg one small, of two to four large.

Male similar to that of *Pandarus*. Antennule with plumose setae. Legs with two-jointed setose rami. Abdomen two-jointed. Caudal rami with long setae.

Type-species : *P. gracilis* Kirtisinghe.

*Discussion.*—Cressey showed that *P. scylli* Yamaguti and Yamasu (1959) is the same as *P. gracilis*. *P. bombayensis* Rangnekar and Rangnekar (1972) and *P. shiinoi* Rangnekar and Rangnekar (1972) do not show any character which distinguishes them from *P. longus* (Gnanamuthu).

*Key to species of* **Pseudopandarus**

1. Genital segment postero-laterally without processes ..... *.longus* (Gnanamuthu)

— Genital segment postero-laterally with processes ..... *.gracilis* Kirtisinghe

## **Pseudopandarus gracilis** Kirtisinghe
(Fig. 44)

*Pseudopandarus gracilis* Kirtisinghe, 1950, p. 83, figs. 13-22 ; 1964, p. 83, fig. 99 ; Yamaguti, 1963, p. 129, pl. 148, fig. 4 ; Cressey, 1967a, p. 30, figs. 147-150.

*Pseudopandarus scylli* Yamaguti and Yamasu, 1959, p. 124, figs. 210-220 ; Yamaguti, 1963, p. 129, pl. 147, fig. 1.

*Female.*—Cephalothorax gradually widening backwards, postero-laterally prolonged into narrow apically rounded lobes, hind border between the lobes transverse. Frontal plates as broad as cephalothorax and projecting. Dorsal plates of second thoracic segment elongated, lateral and overreaching the lobes of the cephalothorax and not overlapping the plates of the third segment. Dorsal plates of third and fourth segments fused, with postero-median sinus,

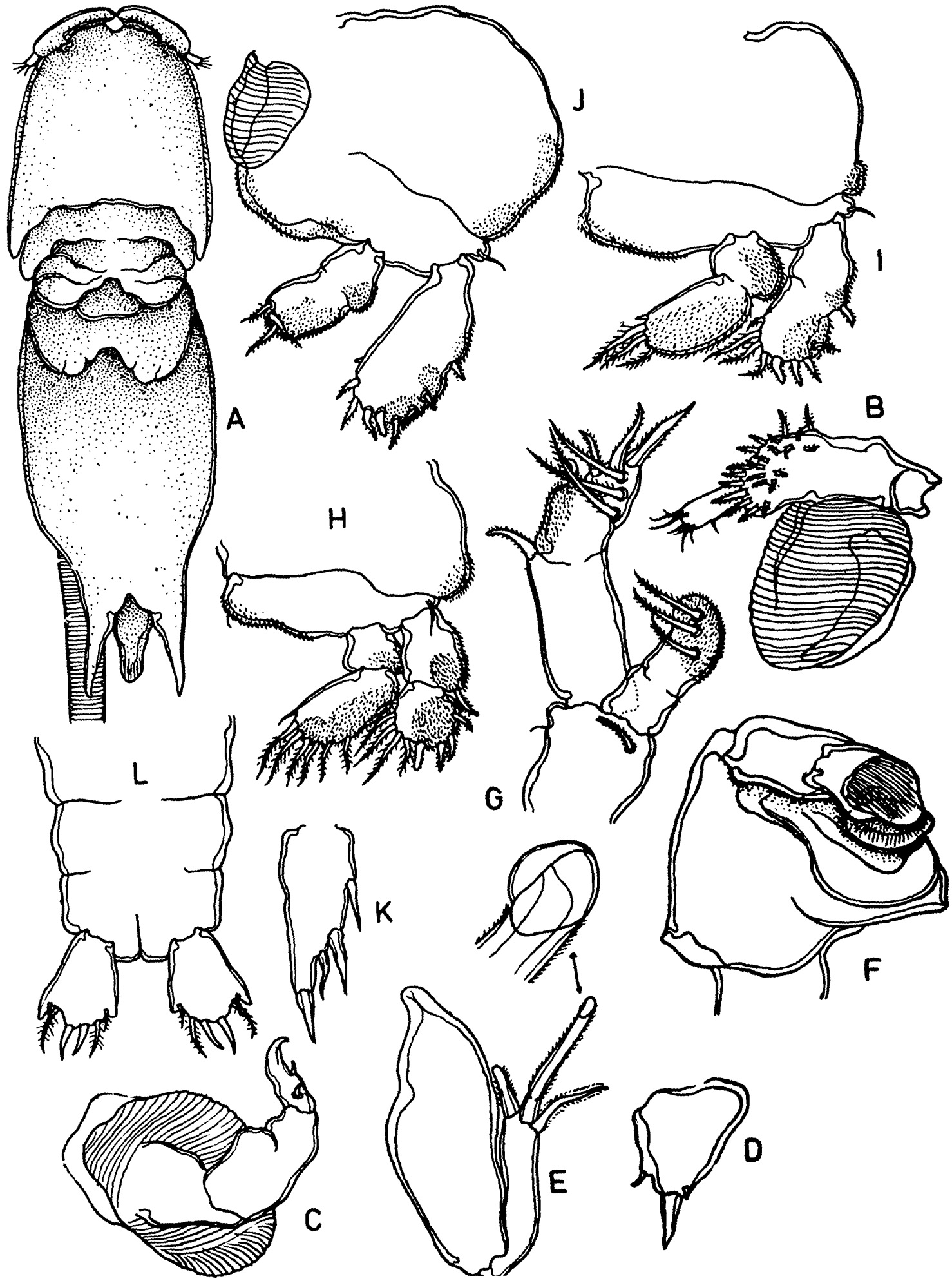


Fig. 44. *Pseudopandarus gracilis* Kirtisinghe : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxillule ; E, maxilla ; F, maxilliped ; G-K, legs 1-5 ; L, abdomen and caudal rami.

fourth nearly twice the size of third. Genital segment very large, narrowed at the distal third and posteriorly produced into three lobes, lateral ones longer than the median and apically narrowing, median process linguiform, covering abdomen and caudal rami. Abdomen squarish, incompletely two-jointed. Caudal rami flattened, with outer distal conical process and six setae.

Basal segment of antennule with blunt pectinate setae, distal segment rather long. Antenna short but stout, second segment with a pad, third short, with two spines. Maxillule with one large median and two small lateral spines, one outer and the other inner. Distal segment of maxilla with all the three claws well developed, outer short blunt and barbed, median long, apically rounded and recurved, inner fairly long and winged. Basal segment of maxilliped with a large and a small adhesion pad, claw spatulate, with irregular border.

Rami of first leg two-jointed, distal segment of endopod prominently spiny and with three long pectinate spines, basal segment of exopod with one spine, distal with four outer rather stout spines and three long slender inner spines. Both rami of second leg spiny, basal exopod segment with one outer spine, second with four spines and five setae, distal endopod segment with seven setae, all spines and setae pectinate. Segmentation of exopod of third leg indistinct, basal segment with one spine, distal with four spines and four setae, second endopod segment with four setae. Basipod of fourth leg enlarged, with an adhesion pad, exopod larger than endopod, one-jointed, with nine spines, endopod indistinctly two-jointed, distal segment with three setae. Fifth leg a conical process with four spines.

*Length.*—4.6 mm.

*Host.—Triakis scyllium, Scoliodon palasorrah.*

*Distribution.*—Sri Lanka, Japan, Madagascar.

*Remarks.*—Cressey has pointed out the defects in the descriptions of this species by Kirtisinghe and Yamaguti and Yamasu. I confirm his observations. But in my specimen the posterior lobes of the

cephalothorax are slightly longer. The segmentation of the abdomen is more distinct. The median claw of the maxilla is apically blunt and recurved, quite different from the illustration provided by Cressey.

## **Pseudopandarus longus** (Gnanamuthu)
(Fig. 45, 46 B)

*Pandarus longus* Gnanamuthu, 1951c, p. 1245, figs. 23-44 ; Kurian, 1955, p. 114, fig. 38 ; Yamaguti, 1963, p. 112 ;
*Pseudopandarus longus* Pillai, 1964b, p. 65, figs. 17-19 ; Cressey, 1967a, p. 31 figs. 151-161.
*Pseudopandarus bombayensis* Rangnekar and Rangnekar, 1972, p. 75, pl. 2, figs. a-p.
*Pseudopandarus shiinoi* Rangnekar and Rangnekar, 1972, p. 79, pls. 3-4, figs. a-o.

*Female.*—Cephalothorax short, as long as broad, broadening backwards, postero-laterally prolonged into conical apically blunt lobes, border between the lobes trilobed. Frontal plates projecting. Dorsal plates of second thoracic segment small, subequal to lobes of cephalothorax, slightly overlapping the plates of the third segment. Plates of third and fourth segments partially fused, with deep posterior median sinus, those of fourth segment larger. Genital segment very large, half the total length, postero-laterally rounded and postero-medially produced into a rounded lobe hiding the abdomen but not the caudal rami. Abdomen long and indistinctly two-jointed. Caudal rami with two setae and four short teeth.

Second segment of antenna with a hump but not a pad, third segment basally swollen, with two sharp spines, distal part slender and claw-like. Maxillule nearly rounded, with two outer and one distal spine. All the porcesses of maxilla well developed, outer process barbed, inner with pectinate flange, median apically rounded and with rows of well spaced sharp spines. Maxilliped with two projecting pads between which the spatulate claw closes.

Rami of legs one to three distinctly two-jointed, of first comparatively slender, others flattened. Rami of fourth leg one segmented, exopod much larger than endopod. Basipod of legs two to four with an adhesion pad. Fifth leg an oval lobe carrying four setiform spines.

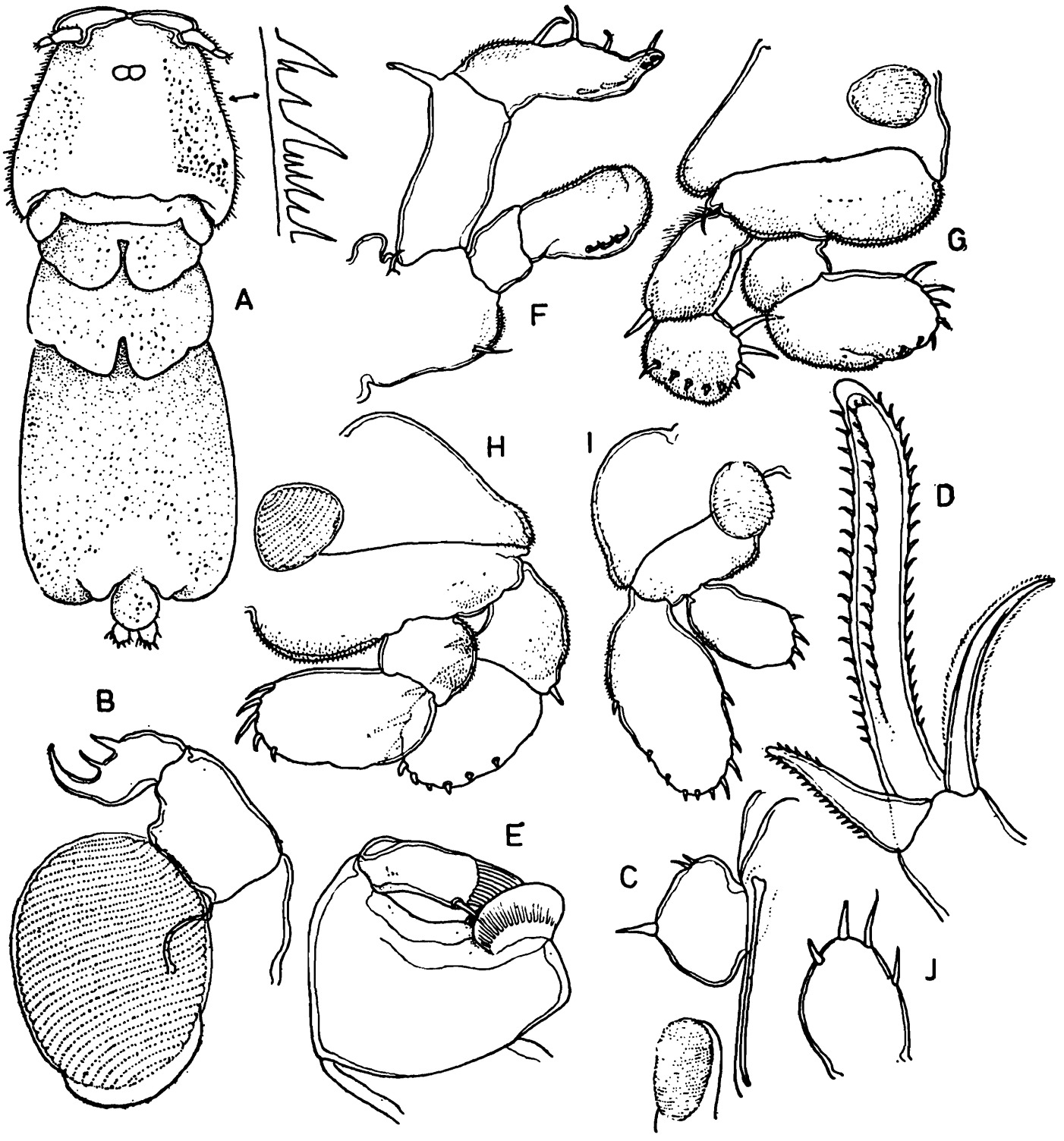


Fig. 45. *Pseudopandarus longus* (Gnanamuthu) : A, female, dorsal view ; B, antenna ; C, maxillule ; D, maxilla ; E, maxilliped ; F-J, legs 1-5.

*Length.*—4.9 mm.

*Male.*—Frontal plates large and projecting. Postero-lateral lobes of cephalothorax separated from second thoracic segment by a wide gap. Second segment postero-laterally produced, third

transversely rectangular, fourth longer than broad. Genital segment longer than broad, with ear-like postero-lateral lobes. Abdomen two-jointed. Caudal rami with plumose setae.

Antennule with plumose setae. Distal segment of antenna more slender. Median process of maxilla basally bulged, outer short, blunt and pectinate. Second segment of maxilliped claw-like. Legs one to four with two-jointed setose rami.

*Length.*—2.4 mm.

*Remarks.*—Rangnekar and Rangnekar created *P. bombayensis* alleging that it differs from *P. longus* in many characters. Gnanamuthu's original description is defective in many respects and the alleged differences concern those characters which Ganamuthu described wrongly. Though they have included the publications of Pillai (1964b) and Cressey (1967a) in the references they do not seem to have consulted them.

The description of *P. shiinoi* contains many defects. The figure of the entire animal shows the cephalothorax in dorsal view and the genital segment and abdomen in the ventral. It is stated that the abdomen is covered by a ventral plate and that the dorsal abdominal plate is absent. Rangnekar and Rangnekar further observed that *P. shiinoi* shows characters of *Parapandarus* Wilson. They are obviously unaware that *Parapandarus* is a synonym of *Phyllothereus*. *Phyllothereus* is very much different from *Pseudopandarus*. *P. shiinoi* as figured by Rangnekar and Rangnekar closely resembles the figure included in this work.

## Genus **Perissopus** Stp. & Lutk.

*Perissopus* Stp. & Lutk., 1861, p. 393 ; Cressey, 1967a, p. 33.
*Achtheinus* Wilson, 1908b, p. 450 ; Cressey, 1967a, p. 34.

*Diagnosis.*—Cephalothorax broadening backwards, with distinct postero-lateral lobes. Frontal plates not separate. Thoracic segments two to four covered by dorsal plates, those of second reaching or overreaching posterior border of those of third, plates of fourth segment longer than those of third and overlapping genital segment.

Genital segment roughly squarish, postero-laterally and postero-medially produced or the hind border bilobed. Abdomen one-segmented, attached to ventral side of genital segment. Caudal rami rudimentary.

Distal segment of antenna with backwardly directed teeth. Basal segment of maxilliped a large adhesion pad, claw very small. Rami of legs one and two two-jointed, of three and four one-jointed, protopods of all the legs flattened laminae.

Male with frontal plates separate. Adhesion pads reduced. Terminal claw of maxilliped large. Legs one to four with two-jointed setose rami. Abdomen two-jointed. Caudal rami terminal.

Type-species : *P. dentatus* Stp. & Lutk.

*Discussion.*—Recent study by Cressey (1967a) following a suggestion by Capart (1953) indicated that all the species so far described under the genus *Perissopus* are synonyms of the type species, *P. dentatus*. Cressey also concluded that *Achtheinus* Wilson is a synonym of *Perissopus* and that probably all the nine species hitherto described are synonyms of *P. oblongatus* (Wilson).

*Key to species of* **Perissopus**

1. Postero-lateral corners of genital segment angular, endopod of legs one to four unarmed ..... *dentatus* Stp. & Lutk.

—Postero-lateral corners of genital segment rounded, endopod of legs one and two with short setae ..... *oblongatus* Wilson

## **Perissopus dentatus** Stp. & Lutk.
(Fig. 46A, C-L)

*Perissopus dentatus* Stp. & Lutk., 1861, p. 393, pl. 2, fig. 25 ; Kirtisinghe, 1964 p. 92, fig. 123 ; Kabata, 1966c, p. 569, fig. 2 ; Hewitt, 1967b, p. 255, figs.149-159 ; Cressey 1967a, p. 35, figs. 152-159.

*Perissopus communis* Rathbun, 1887, p. 560, pl. 29, figs. 6-7, pl. 30, figs. 1, 6 ; Wilson, 1907b, p. 354, pls. 17-18.

*Perissopus crenatus* Leigh Sharpe, 1930, p. 7, pl. 5, figs. 1-4, pl. 4, fig. 2.

*Perissopus manuelensis* Gnanamuthu, 1951f, p. 8, figs. 1-5 ; Pillai, 1964f, p. 67, figs. 40-59.

*Perissopus travancorensis* Kurian, 1955, p. 108, figs. 154-161.

*Perissopus serratus* Heegaard, 1962, p. 175, figs. 154-161.

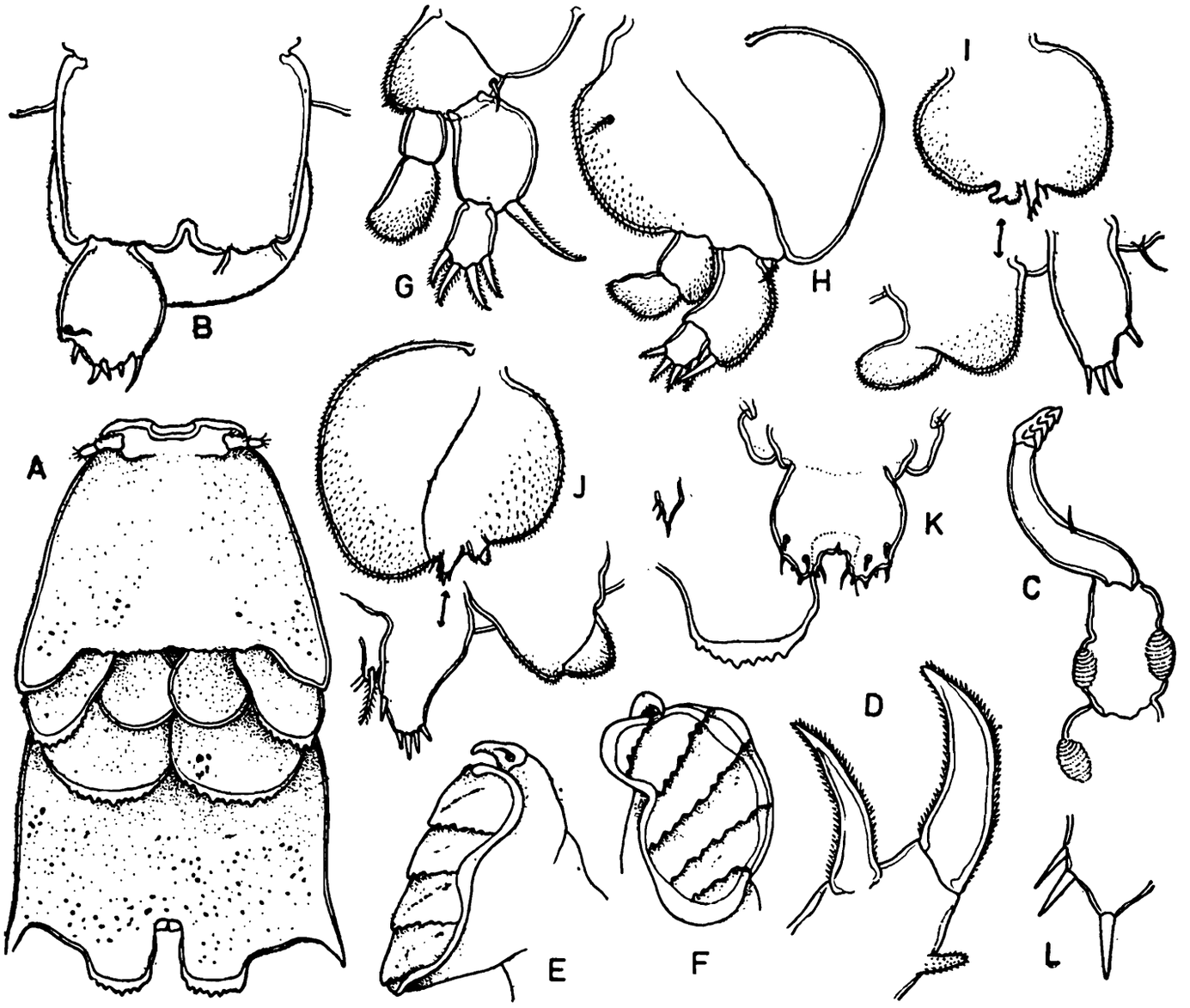


Fig. 46. *Perissopus dentatus* Stp. & Lutk.; A, female, dorsal view; B, abdomen and caudal ramus of *Pseudopandarus longus* ; C, Antenna ; D, maxilla ; E-F, maxilliped ; G-J, legs 1-4 ; K, leg 5, abdomen and caudal rami ; L, leg 5.

*Female.*—Cephalothorax roughly triangular, postero-laterally produced into apically blunt slanting lobes overlapping the dorsal plates of second thoracic segment. Dorsal plates of second segment wide apart, slanting and partly covering plates of third and fourth segments, those of third much smaller than those of fourth, hind border of all the plates irregularly crenate. Genital segment squarish, postero-laterally produced into apically acute processes turned inwards, outwards or backwards. Postero-median part produced into a pair of squarish lobes with bluntly serrate border. Abdomen attached to ventral side of genital segment, a very small part dorsally

visible. Caudal rami short irregular plates fused with the abdomen, armed with four setae and three spines.

First segment of antenna with one and second with two adhesion pads, third with two rows of backwardly directed teeth. Maxillule with two outer and one apical strong spines. Maxilla with a narrow dentate inner and strong median claws and short spiny outer process. Maxilliped a strong adhesion pad, its surface showing the contour of the body surface of the host, claw small, curving over the pad.

First leg small, with two-jointed rami. Basipod of second large, rami two-jointed. Basipod of third and fourth legs very large, rami reduced in size, exopod one-segmented, endopod indistinctly two-jointed. Fifith leg a small process with three spines, sixth formed of two contiguous lobes.

*Length.*—4.2 mm.

*Male.*—Cephalothorax rounded. Frontal plates separate. Genital segment longer than broad, postero-laterally rounded. Antenna stouter than in female, third segment without teeth. Distal segment of maxilliped claw-like closing against a patch of strong ridges. Legs with two-jointed setose rami.

*Length.*—2.9 mm.

*Host.*—A wide variety of elasmobranchs, mostly inshore species (for list see Hewitt 1967b).

*Distribution.*—Cosmopolitan.

*Remarks.*—Pillai (1964b) described a pandarid male collected along with females as that of *P. dentatus.* This male has a one-segmented abdomen. But Cressey described a male found in copula and its abdomen is two-jointed. According to Cressey only *Nesippus* male has a one-jointed abdomen. If this is so what I described is a male *Nesippus.* Gnanamuthu (1951f) described a male with one-segmented abdomen. Its fourth leg has one-jointed rami while Pillai's male had two-jointed rami.

## Genus **Nesippus** Heller

*Nesippus* Heller, 1868, p. 193 ; Yamaguti, 1963, p. 122 ; Cressey, 1967a, p. 59.

*Diagnosis.*—Cephalothorax comparatively large. Frontal plates large and separate. Thoracic segments two to three without dorsal plates, fourth may have dorsal plates. Genital segment large. Abdomen small, one-segmented, attached to ventral side of genital segment. Caudal rami terminal. Adhesion pads present on cephalic and thoracic appendages. Cephalic appendages generally as in the family. Maxilliped subchelate, claw blunt or pointed. Legs one to three with two-jointed rami, with large plumose setae, those of fourth one-jointed, endopod may be modified and without setae. Fifth leg present, sixth absent.

ale with short one-segmented abdomen. Endopod of leg three slightly modified. Sixth leg present.

Type-species : *N. orientalis* Heller

*Discussion.*—According to Cressey (1967a) this genus contains only four valid species. Since then Cressey described *N. nana* from the American waters.

Cressey observed that *Nesippus* belongs to the group of species with only two claws on the second segment of the maxilla, the third process being replaced by a bunch of hairs. But in *N. vespa* and *N. crypturus* the outer and inner processes are subsimilar and in *N. orientalis* there is only a tubercle. *N. tigris* has a medium sized outer process. It is worth mentioning that I have studied material kindly sent by Cressey.

### *Key to species of* **Nesippus**

1. Endopod of leg four without long setae 2

— Endopod of leg four with long setae .3

2. Genital segment conspicuously narrowed anteriorly, caudal rami with prominent setae *crypturus* **Heller**

— Genital segment not conspicuously narrowed anteriorly, caudal rami with small setae *tigris* Cressey

3. Fourth thoracic segment with wing-like plates *orientalis* Heller

— Fourth thoracic segment without wing-like plates *.vespa* Kirtisinghe

## **Nesippus crypturus** Heller
(Fig. 47, 48 A-K.)

*Nesippus crypturus* Heller, 1868, p. 196, pl. 18, fig. 4 ; Yamaguti, 1963, p. 124, pl. 143, fig. 2 ; Lewis, 1966b, p. 116, figs. 27-30 ; Cressey, 1967a, p. 61, figs. 305-324.

*Nesippus occultus* Wilson, 1924b, p. 214 ; Yamaguti, 1963, p. 124, pl. 142, fig. 3.

*Nesippus costatus* Wilson, 1924, p. 213 ; Yamaguti, 1963, p. 124, pl. 142, fig. 2.

*Nesippus gracilis* Wilson, 1935b, p. 4 ; Yamaguti, 1963, p. 124.

*Female.*—Cephalothorax much broader than long, with a pair of longitudinal ribs, postero-lateral lobes large, reaching the tip of the third thoracic segment. Frontal plates large, incompletely fused with cephalothorax, forming an independant anterior lobe. Second thoracic segment short, laterally expanded into large lobes. Third segment triangular, slightly overlapping fourth segment. Fourth segment elongated, with a pair of small but prominent lobes situated postero-laterally. Genital segment large, roughly oblong, with very short anterior neck, posteriorly deeply cleft, cleft one third the length of the segment, the posterior lobes of genital segment evenly rounded (specimen illustrated was slightly abnormal). Abdomen small and one-segmented, fully hidden by the genital segment. Caudal rami dorsally visible, with four long and two short setae.

Basal segment of antennule associated with a digitiform chitinised adhesion process. Antenna associated with a projecting adhesion pad, its basal segment with two pads, middle segment with one outer distal pad, distal segment slender and well curved, with two spines. Maxillule as in male. Maxilliped with a prominent sucker-like disc, claw spatulate, with a strong spine.

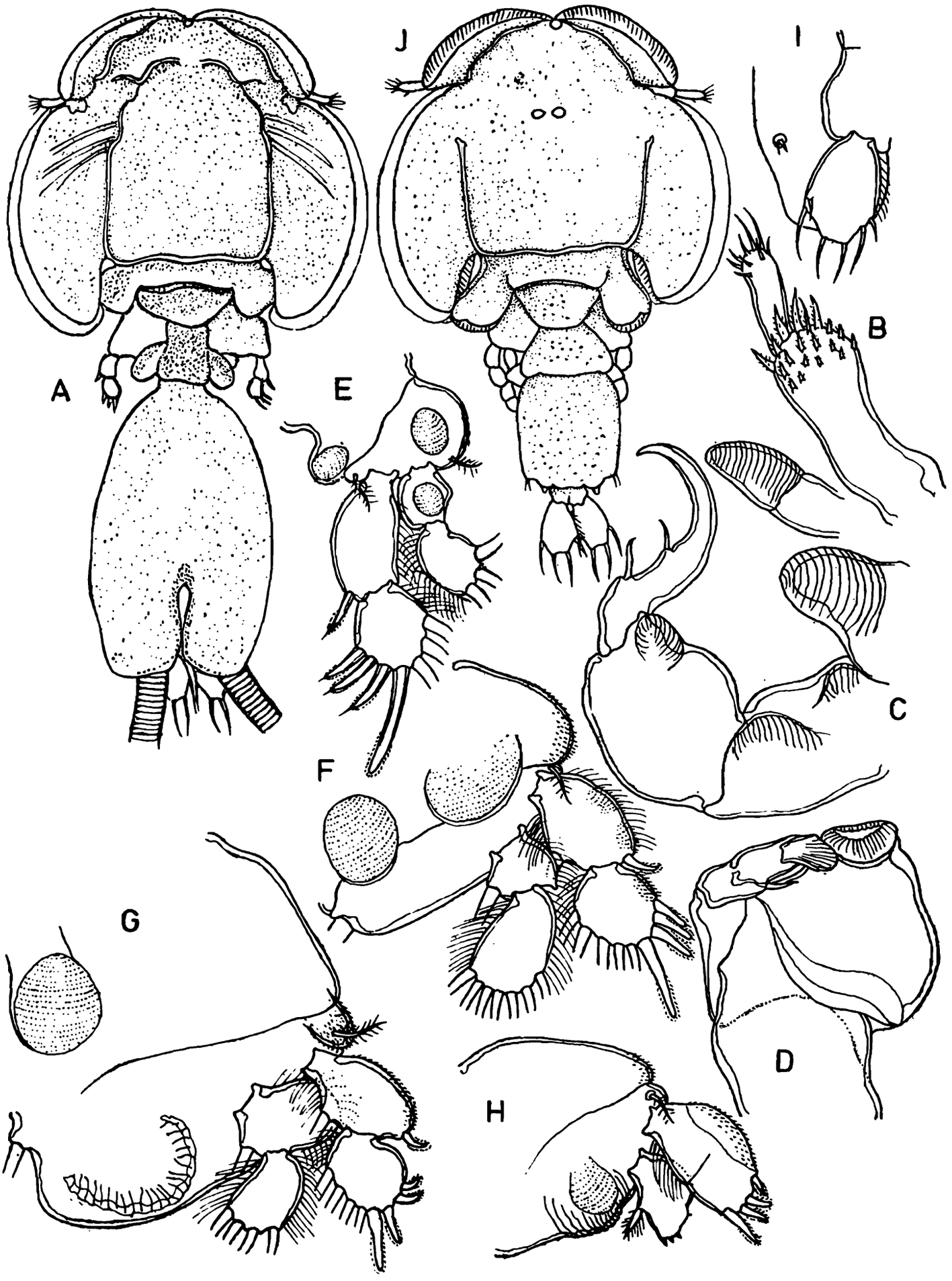


Fig. 47. *Nesippus crypturus* Heller : A-I, Female. A, female, dorsal view ; B, antennule ; C, antenna ; D, maxilliped ; E-H, legs 1-4 ; I, leg 5, abdomen and caudal ramus. J, Male, dorsal view.

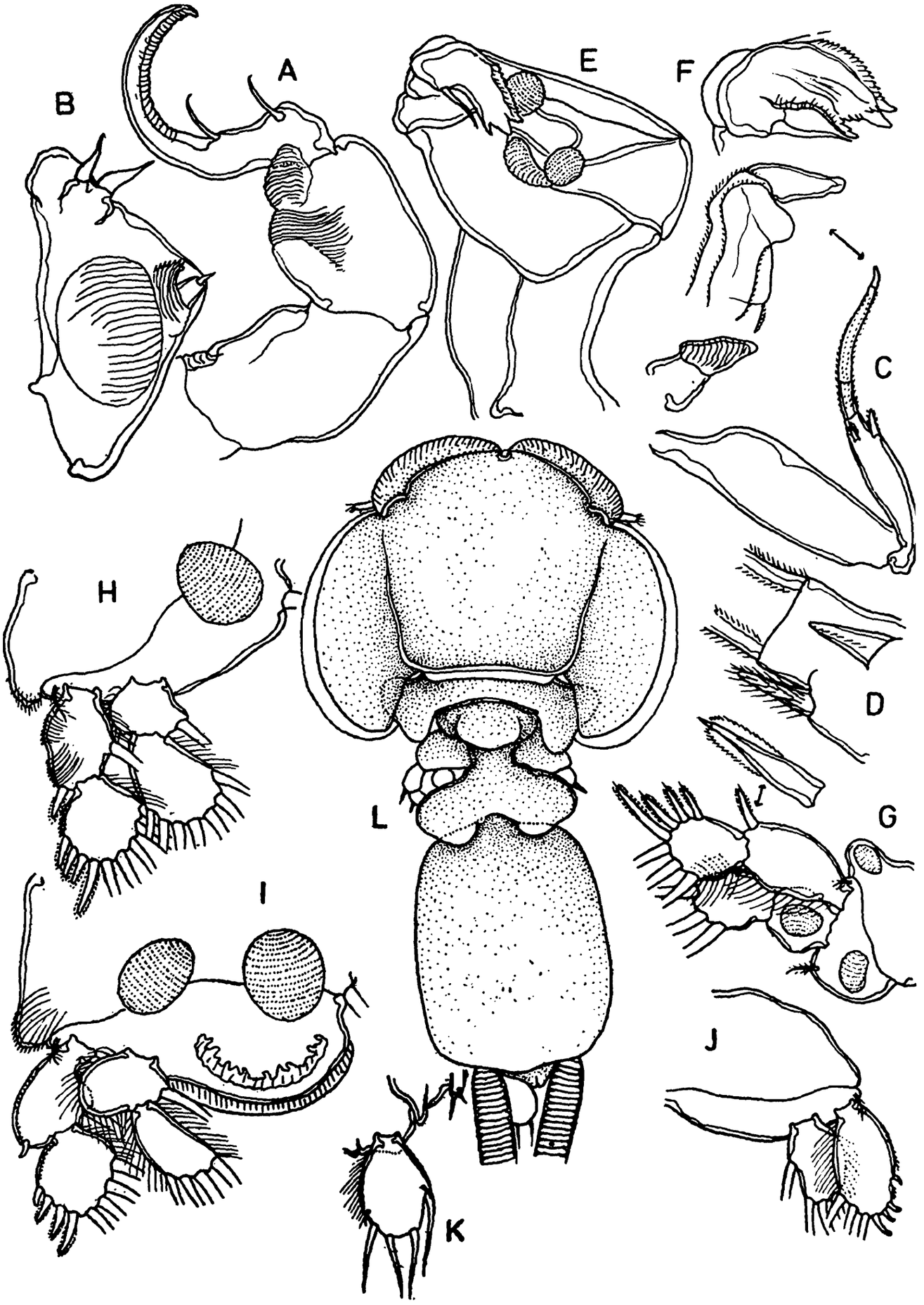


Fig. 48. A-K. *Nesippus crypturus* (contd.) ; Male. A, antenna ; B, maxillule ; C, maxilla ; D, same, claws enlarged ; E, maxilliped ; F, same, claw enlarged ; G-J, legs 1-4 ; K, leg 5 and caudal rami. L, *Nesippus orientalis* Heller, female, dorsal view.

Basipod of first leg with two adhesion pads, first segment of exopod with one and second with four long claws, last claw very long, basal segment of endopod with an adhesion pad. Basipod of second leg with two adhesion pads, exopod with spiny outer surface, claws as in first leg. Basipod of third leg with one adhesion pad, endopod smaller than exopod, its basal segment internally expanded, claws on exopod rather short. Exopod of fourth leg indistinctly two-jointed, with four claws, no setae, endopod one-jointed, with one seta and three denticles, basipod with one pad. Fifth leg composed of two setae.

*Length.*—4.8 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+IV |
| Leg 2 | 1+0, 7 | 1+I, 5+IV |
| Leg 3 | 1+0, 4 | 1+I, 4+IV |
| Leg 4 | 1+III | IV |

*Male.*—Cephalothorax slightly narrower than in female, frontal plates more projecting. Second and third thoracic segments comparatively longer. Fourth segment triangular, broadening backwards and as broad as genital segment. Latter roughly squarish, with two pairs of posterior projections. Abdomen very short, one-segmented. Caudal rami large, with four long and two short, setae.

Antenna stouter than in female, middle segment with two pads, distal segment with two slender spines and its inner surface grooved beyond the second spine. Maxillule with two stout anterior spines and median process carrying spines, ventral surface with large adhesion pad. Maxilla associated with a projecting pad, distal segment with short inner and outer processes, median process with irregular tip. Basal segment of maxilliped with three pads, claw apically trifid, with external serrate flange and long internal spine. Legs one to three with two-jointed and fourth with one-jointed rami.

*Length.*—3.8 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+IV |
| Leg 2 | 1+0, 7 | 1+I, 5+IV |
| Leg 3 | 1+0, 4 | 1+I, 4+IV |
| Leg 4 | 4 | 3+IV |

*Host.*—A wide variety of sharks mostly inhabiting the inshore waters.

*Distribution.*—Cosmopolitan.

*Remarks.*—The shape of the genital segment of the female is slightly different as the specimen illustrated was slightly abnormal. However Cressey has shown it as narrower and Lewis broader. The fourth leg shows much difference from that illustrated by Cressey. The armature of the claw of the maxilliped of the male differs from previous descriptions.

**Nesippus orientalis** Heller
(Fig. 48L, 49 A-I)

*Nesippus orientalis* Heller, 1868, p. 194, pl. 18, figs. 2-3 ; Yamaguti, 1963, p. 123, pl. 143, fig. 1 ; Cressey, 1967a, p. 60, figs. 295-304 ; Hewitt, 1967b, p. 183, figs. 1-9.

*Nesippus alatus* Wilson, 1905b, p. 130 ; Yamaguti, 1963, p. 123, pl. 140, fig. 3.

*Nesippus ornatus* Thomsen, 1949, p. 17, pl. 6, figs. 1-11 ; Yamaguti, 1963, p. 124 pl. 137, fig. 5.

*Nesippus australis* Heegaard, 1962, p. 178, figs. 162-172.

*Female.*—Cephalothorax much broader than long, postero-lateral lobes large, curving inwards, not reaching hind border of third segment. Frontal plates rather low. Second thoracic segment laterally expanded into prominent lobes with outer and distal expansions, latter reaching beyond the third segment. Third segment transversely oblong, postero-medially bulging. Fourth segment long, with a pair of well developed wings or dorsal plates slightly overlapping genital segment. Genital segment large, longer than

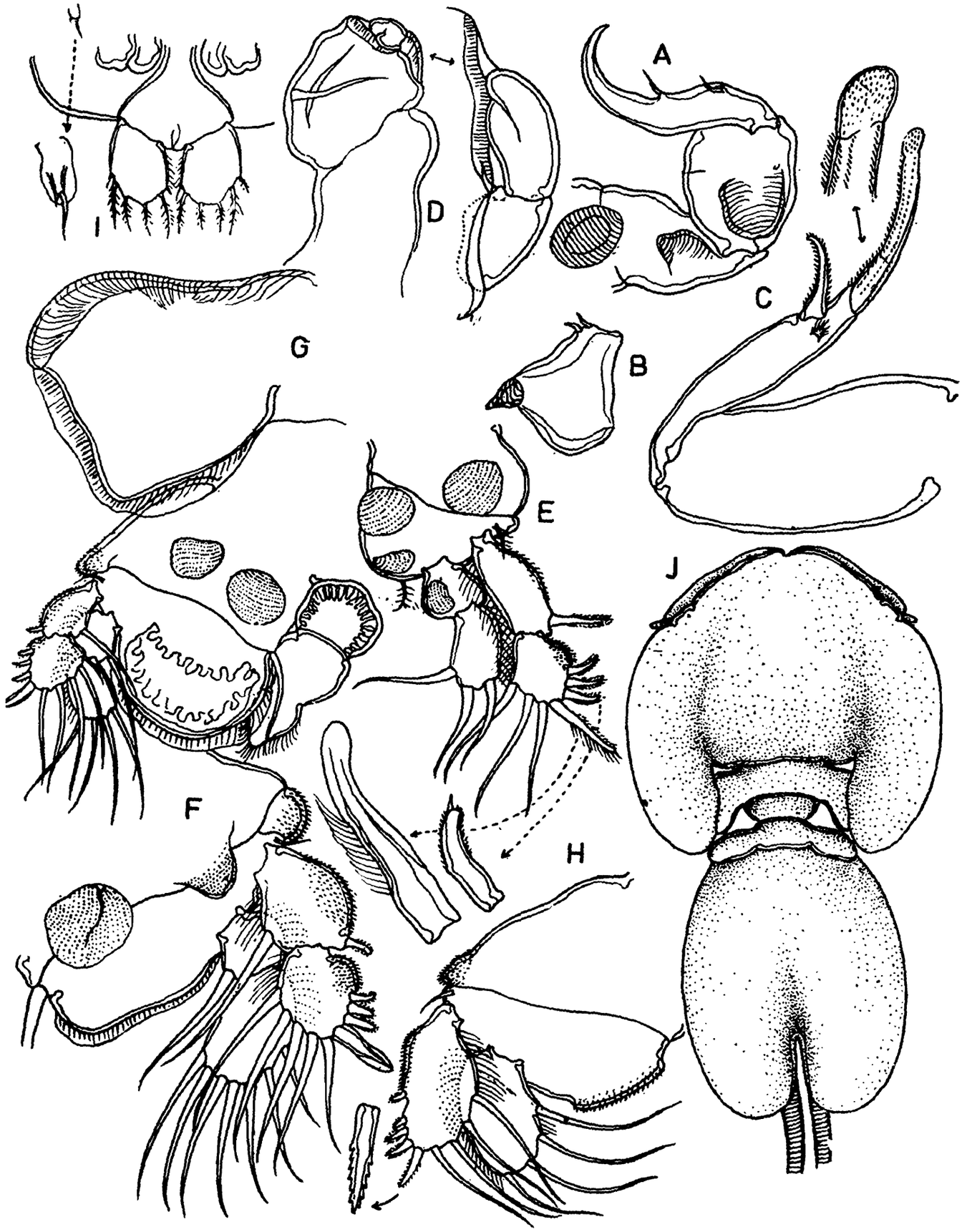


Fig. 49. A-I. *Nesippus orientalis* (contd.) ; A, antenna ; B, maxillule ; C, maxilla; D, maxilliped ; E-H, legs 1-4 ; I, leg 5, abdomen and caudal rami J, *Nesippus tigris* Cressey, female, dorsal view.

broad, slightly widening backwards, postero-medially slightly produced. Abdomen diamond-shaped, projecting beyond genital segment. Caudal rami slightly longer than broad, fully exposed with four long and two short setae.

First two segments of antenna with an adhesion pad, third long and only moderately curved, with two spines. Maxillule triangular, with two proximal spines and one strong grooved apical tooth. Basal segment of maxilla stout, distal with a small spiny outer tubercle, inner process barbed and claw-like, median long, with rounded apical lobe. Maxilliped rather elongated, basal segment with sucker-like pad, claw spatulate.

Basipod of first leg with three adhesion pads, basal segment of endopod with one pad, claws on exopod dissimilar in armature. Basipod of second leg with two pads, last claw on exopod stout and distally flanged. Basipod of third leg with two pads, its ventral part highly expanded and nearly semicircular. Basipod of fourth leg without pad, with a low spiny ventral lobe, rami one-jointed, endopod not modified. Fifth leg a small lobe carrying a long and a short seta.

*Length.*—5.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+IV |
| Leg 2 | 1+0, 7 | 1+I, 5+IV |
| Leg 3 | 1+0, 4 | 1+I, 5+IV |
| Leg 4 | 4+0 | 4+V |

*Host.*—Several species of inshore sharks.

*Distribution.*—Cosmopolitan.

*Remarks.*—Compared to the description given by Cressey the following differences were observed. The lobes of the second thoracic segment and the plates of the fourth segment are slightly different in shape. The adhesion pad near the antennule is mounted on a peduncle. First and second antennal segments carry pads. the basal segment of the maxilliped has a large sucking disc. The legs also show some minor differences.

The presence of large plates on the fourth segment and the absence of a posterior sinus on the genital segment distinguish this species.

## **Nesippus tigris** Cressey
(Fig. 49 J, 50)

*Nesippus tigris* Cressey, 1967a, p. 63, figs. 325-345 ; 1970, p. 12, fig. 38.

*Female.*—Cephalothorax much broader than long, antero-medially angular and postero-laterally produced into large distally broadly rounded lobes almost reaching the middle of the fourth thoracic segment. Frontal plates rather small and displaced to the ventral side. Second thoracic segment laterally expanded into moderately large lobes contacting the lobes of the fourth segment and overlapped by the lobes of the cephalothorax. Third thoracic segment very small. Fourth with a pair of oblong lobes directed outwards. Genital segment ovate, highly enlarged, posteriorly forming two rounded lobes separated by a deep sinus about a third of the length of the segment. Abdomen nearly twice as broad as long. Caudal rami nearly circular, with four small spiniform setae and two small inner setules.

Basal segment of antennule broadening distalwards, distal part with short setae, marginal ones sharp, others blunt. First two segments of antenna stout, third moderately stout and distally curved, no pads. Maxillule with two spines and a blunt tooth. Maxilla robust, median process of distal segment very stout, inner strongly curved, outer small. Maxilliped long and slender, like that of *N. vespa*, with a small projecting circular disc, distal segment slender, apically blunt, with a spine.

Basipod of first leg with two very indistinct pads, basal segment of endopod without pad, exopod comparatively broad, with fairly sharp spines. Basipod of second leg without pads, rami subsimilar, spines as on first exopod. Basipod of third leg expanded on ventral side, rami like those of second leg, exopod with smaller spines. Basipod of fourth leg clearly two-jointed, rami one-jointed, both rami reduced, exopod larger and with four small spines, endopod without any armature. Fifth leg composed of a tubercle and a seta.

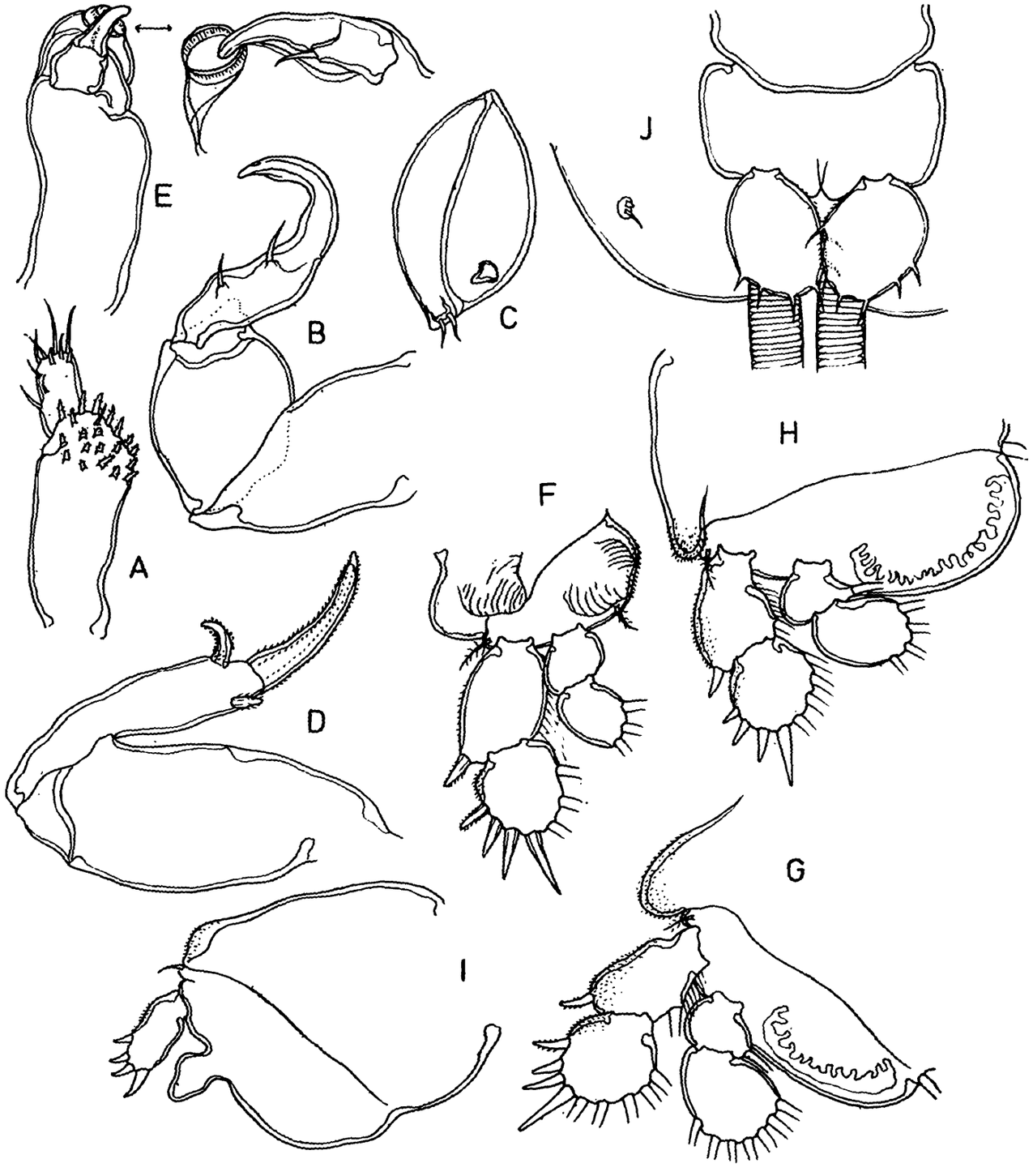


Fig. 50. *Nesippus tigris* (contd.) ; A, antennule ; B, antenna ; C, maxillule ; D, maxilla ; E, maxilliped ; F-I, legs 1-5 ; J, leg 5, abdomen and caudal rami.

*Length.* 8.0 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+IV |
| Leg 2 | 1+0, 7 | 1+I, 5+IV |
| Leg 3 | 1+0, 4 | 1+I, 4+IV |
| Leg 4 | 0+0 | IV |

*Host.—Galeocerdo cuvier.*

*Distribution.*—Indian Ocean (Madagascar), Atlantic Ocean (Florida).

*Remarks.* In the very small, ventrally placed frontal plates, large elegantly rounded genital segment with deep posterior sinus, broad abdomen and caudal rami with setae converted into spines, this species differs from all the others. The appendages have a robust appearance and the reduction of both rami of fourth leg is very characteristic.

The lobes of the fourth thoracic segment are larger than shown by Cressey, maxilla has a distinct, though small, outer process instead of hairs and the spines on the caudal rami are longer. The endopod of leg four is different in shape.

## **Nesippus vespa** Kirtisinghe
(Fig. 51)

*Nesippus vespa* Kirtisinghe, 1964, p. 91, figs. 115-122 ; Cressey, 1967a, p. 65, figs. 346-356 ; Pillai, 1968b, p. 18, fig. 5.

*Female.*—Cephalothorax broader than long, postero-laterally produced into large lobes not reaching the tip of the lobes of the second segment. Frontal plates large and projecting. Posterior border of cephalothorax transverse, with prominent lateral incisions. Second thoracic segment laterally produced into large lobes stopping far short of the tip of the third segment. Third segment comparatively long, postero-medially produced and rather immersed in second segment. Fourth segment medially produced outwards, without plates. Genital segment with distinct anterior neck, rest of the segment oblong, deeply incised posteriorly. Abdomen

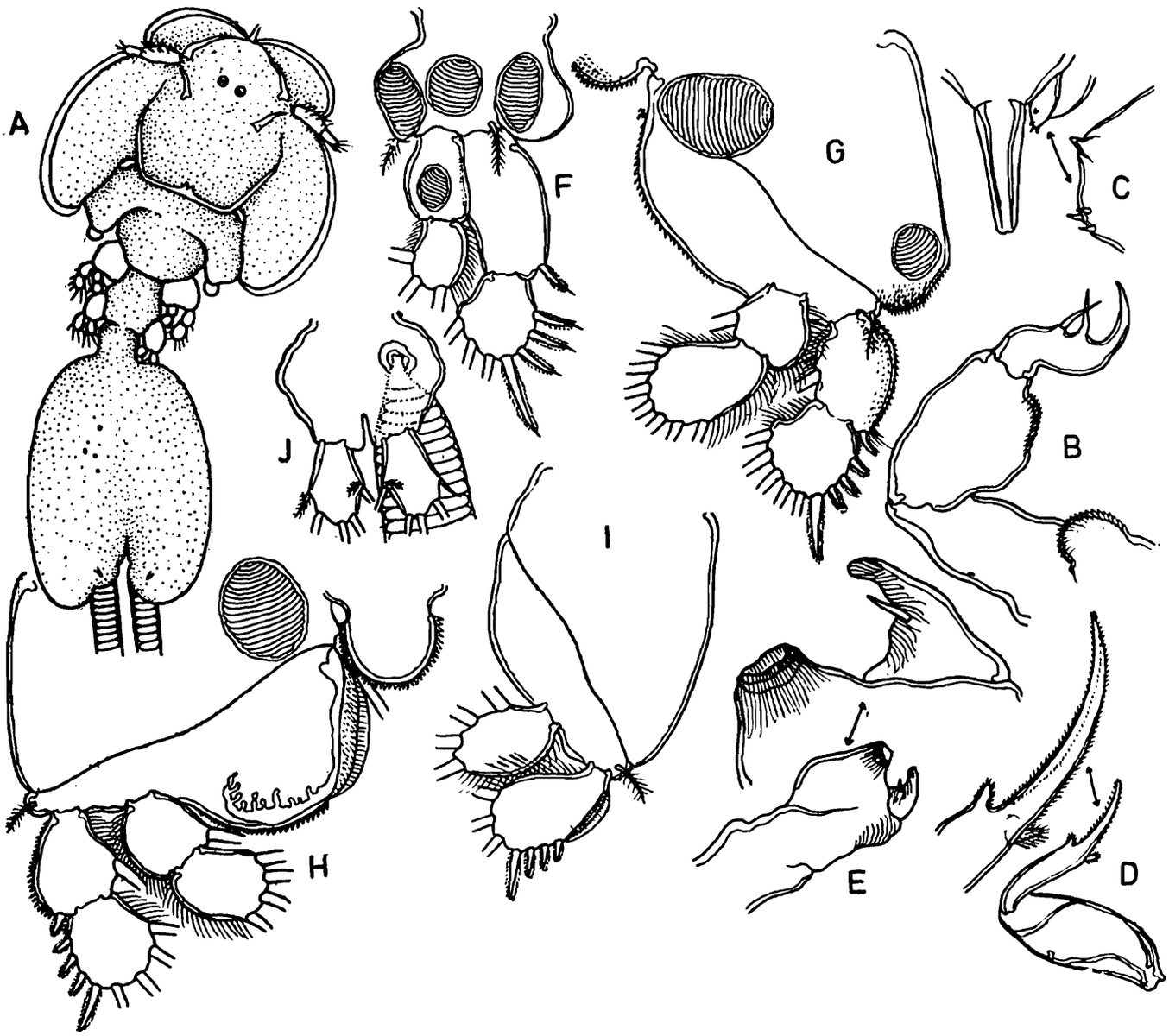


Fig. 51. *Nesippus vespa* Kirtisinghe : A, female, dorsal view ; B, antenna ; C, maxillule ; D, maxilla ; E, maxilliped ; F-I, legs 1-4 ; J, abdomen and caudal rami.

broader than long, not dorsally visible. Caudal rami with four large and two small setae.

Basal segment of antennule short, with very few setae. First and second segments of antenna stout, each with an adhesion pad, third segment with two very long spines, claw beyond the spines slender and well curved. Maxillule with three dorsal spines and an apical process. Distal segment of maxilla with inner process smaller than outer, median process large, as long as the second

segment. Basal segment of maxilliped with projecting inner distal adhesion pad, claw narrowing, spine rather strong.

Basipod of first leg with three pads, first segment of endopod with one pad, claws on exopod as in *N. crypturus*. Basipod of second and third legs expanded, that of third forming a large lower lobe, of second with two pads and of third with one, rami subsimilar. Basipod of fourth leg small, without pad, rami one-jointed, endopod not modified. Fifth leg a small process carrying one seta.

*Length.*—3.3 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+IV |
| Leg 2 | 1+0, 7 | 1+I, 5+IV |
| Leg 3 | 1+0, 4 | 1+I, 4+IV |
| Leg 4 | 4 | 3+IV |

*Host.—Rhynchobatus djeddensis.*

*Distribution.*—Sri Lanka, India (Kerala), Madagascar.

*Remarks.*—The female illustrated by Kirtisinghe has a shorter genital segment and the abdomen and caudal rami are exposed. In my specimens they are concealed as illustrated by Cressey. The inner process of the maxilla is dentate and not naked as shown by Cressey and instead of a bunch of hairs there is a distinct outer process which is longer than the inner. *N. vespa* can be easily identified by the very narrow fourth thoracic segment devoid of plates or lobes creating a real waist to which the specific name alludes.

## Genus **Echthrogaleus** Stp. & Lutk.

*Echthrogaleus* Stp. & Lutk., 1861, p. 380 ; Yamaguti, 1963, p. 118 ; Cressey, 1967a, p. 53.

*Diagnosis.*—Cephalothorax large, with lateral constrictions, postero-laterally produced into large lobes. Frontal plates small, separate. Second thoracic segment laterally expanded into large lobes. Fourth segment short, with large elytra-like dorsal plates

covering nearly half of the genital segment. Latter large, as long as cephalothorax, postero-laterally forming large lobes and postero-medially a small lobe overlapping abdomen. Abdomen one-segmented. Caudal rami terminal.

Antenna with adhesion pads. Maxilla with outer process in the shape of a hemispherical spiny bulge. Maxilliped with spatulate or dactyliform distal segment. Basipods of legs one to three with prominent pads, rami of first two-jointed, exopod of second and third three and endopod two-jointed. Basipod of fourth leg small, rami one-jointed, lamellar. Fifth leg a chitinised process carrying a tooth and two to three spines.

Cephalothorax of male narrower. Fourth segment with indications of dorsal plates in the form of two small lobes overlapping genital segment. Genital segment squarish. Abdomen two-jointed. Caudal rami with plumose setae. Segmentation of rami of legs two to three as in female, distal endopod segment of third leg modified, rami of fourth leg two-jointed, not lameller.

Type-species : *E. coleoptratus* (Guerin).

*Discussion.*—The six species till then described under the genus were reduced to three by Cressey (1967a), namely *E. coleoptratus*, *E. denticulatus* and *E. torpidinis*. But Kirtisinghe (1964) in the meanwhile described a fourth, *E. pectinatus*, and Shiino (1963) described *E. pellucidus*.

In his key to species Cressey wrote of *E. coleoptratus* that the "posterior border of dorsal plates is smooth" The border is feebly but definitely denticulated. Denticulation of the dorsal plates is apparently a generic character.

Cressey clearly states that in this genus dorsal plates are present only on the fourth segment. But Yamaguti, Shiino and Hewitt described dorsal plates on the second and third segments also. The second segment has lateral expansions as in *Nesippus* but they are not dorsal plates. The third segment has its postero-lateral parts produced into small lobes. They are also not dorsal plates. Shiino mentions dorsal plates in *E. denticulatus* but calls identical structures

in *E. coleoptratus* lateral plates. There is thus much confusion and Cressey is correct in recognising dorsal plates only on the fourth segment.

In *Echthrogaleus* instead of an outer spine there is a hemispherical bulge on the distal segment of the maxilla. But on the distal part of this bulge there is a distinct blunt process which is undoubtedly the counterpart of the spine. Thus as already indicated the structure of the maxilla is the same in all pandarids, the difference is only in the size of the process. Even when only a bunch of hairs is evident this is placed on a small projection. It appears that the outer process of the maxilla of pandarids is the homologue of the outer thin flange of caligids which in euryphorids like *Alebion* and *Elytrophora* is strongly spiny.

*Key to species of* **Echthrogaleus**

| | | |
|---|---|---|
| 1. | Dorsal plates of fourth segment very small, not overlapping genital segment | .*pectinatus* Kirtisinghe |
| — | Dorsal plates of fourth segment large, overlapping genital segment | .2 |
| 2. | Dorsal plates of fourth segment with antero-lateral spine-like projection | .3 |
| — | Dorsal plates of fourth segment without antero-lateral spine-like projection | .*torpedinis* Wilson |
| 3. | Posterior border of dorsal plates prominently denticulate, fifth leg dorsally visible | .*denticulatus* Smith |
| — | Posterior border of dorsal plates feebly denticulate, fifth leg not dorsally visible | .*coleoptratus* (Guerin) |

## **Echthrogaleus coleoptratus** (Guerin)
(Figs. 52 A-C, 53, 54 A-K.)

*Echthrogaleus coleoptratus* Stp. & Lutk., 1861, p. 380, pl. 8, fig. 15 ; Wilson, 1907b, p. 367, pl. 19 ; Yamaguti, 1936c, p. 7, pl. 4 ; Shiino, 1954d, p. 291, figs. 1-3 ; Hewitt, 1967b, p. 223, figs. 94-101 ; Cressey, 1967a, p. 54, figs. 264-280.

*Female.*—Cephalothorax much broader than long, with very prominent median lateral constriction continued inwards as transverse grooves. Frontal plates low but placed on a projecting lobe.

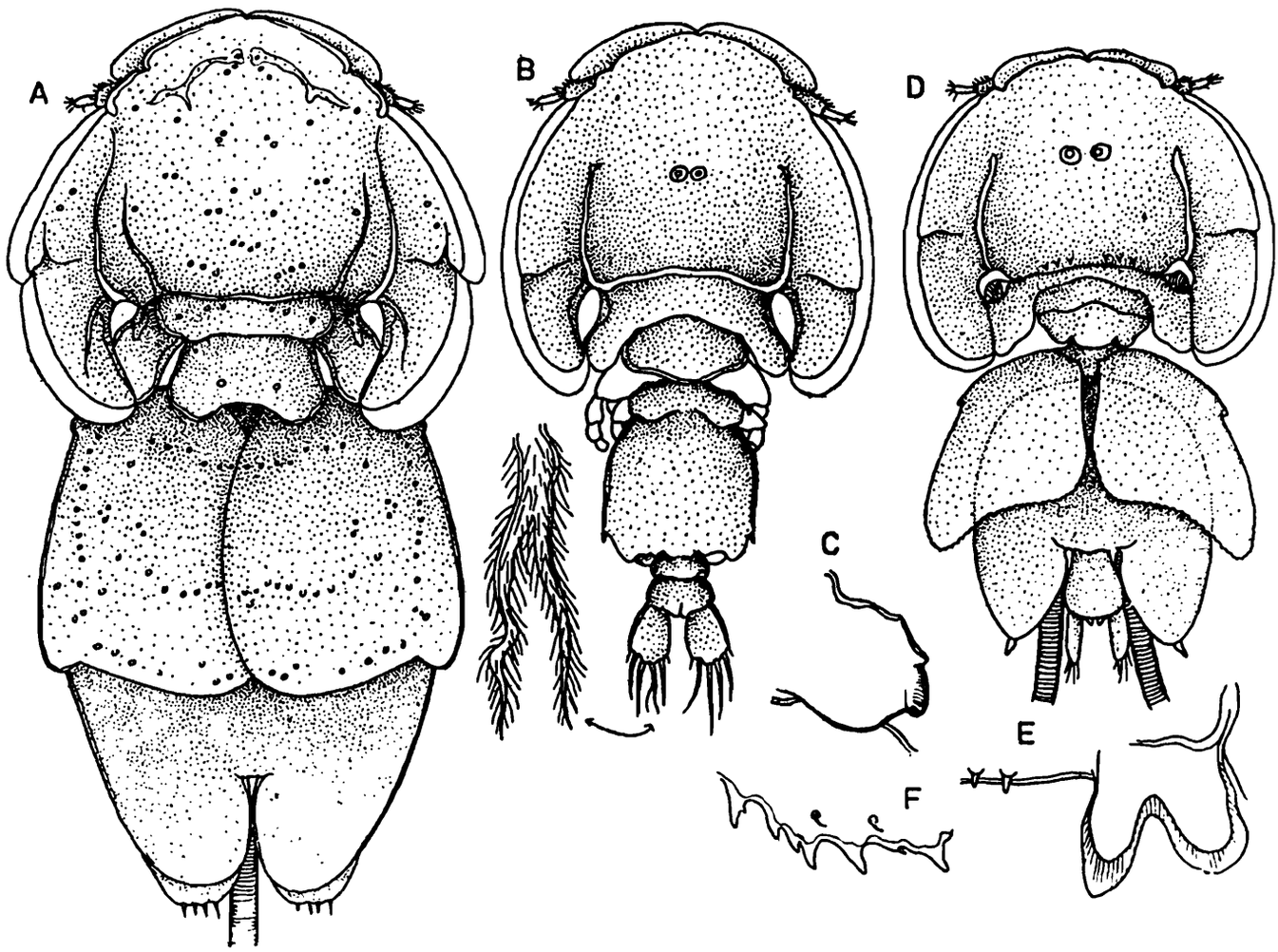


Fig. 52. A-C. *Echthrogaleus coleoptratus* (Guerin) : A, female, dorsal view ; B, male, dorsal view ; C, dorsal plate of fourth segment, male ; D-F. *Echthrogaleus denticulatus* Smith : D, female, dorsal view ; E, hind border of cephalothorax ; F, border of dorsal plate of fourth segment.

Postero-lateral lobes very narrow, curving inwards and slightly overlappping fourth segment. Second thoracic segment laterally produced into large lobes reaching the tip of the lobes of cephalothorax. Third segment rectangular, postero-laterally produced over fourth segment. Dorsal plates of fourth segment very large, covering more than half of the genital segment, with antero-lateral and outer-distal concavity, hind border feebly dentate. Genital segment with deep postero-median sinus, lobes rounded and nearly touching. Abdomen not visible dorsally, slightly broader than long, attached to ventral side of genital segment. Caudal rami laminate, longer than broad, with six very small setae, just projecting beyond the genital segment. Dorsal side of cephalothorax and dorsal plates with transparent spots.

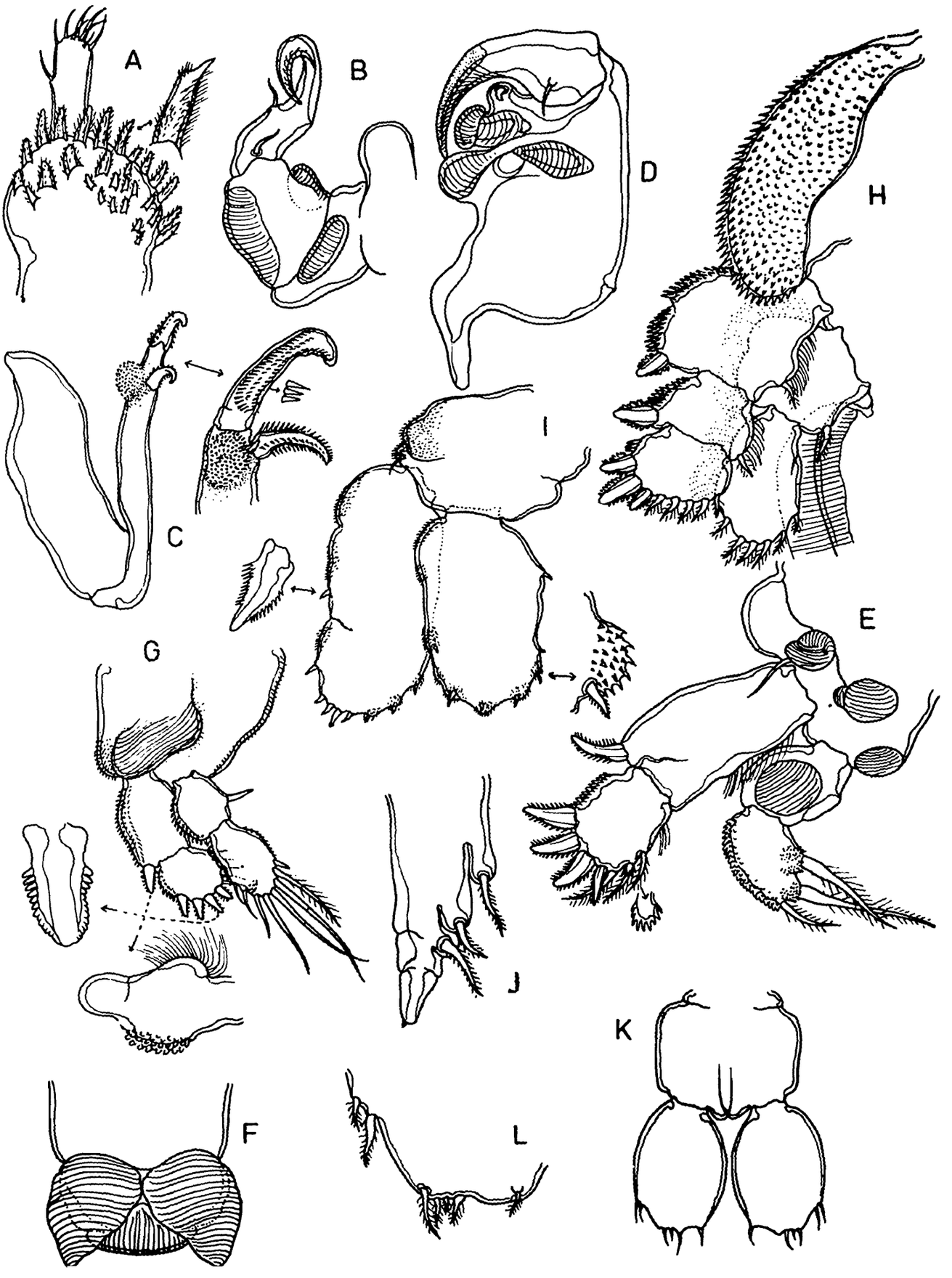


Fig. 53. *Echthrogaleus coleoptratus* (contd.) ; Female. A, antennule ; B, antenna ; C, maxilla ; D, maxilliped ; E, leg 1 ; F, same, intercoxal plate ; G, leg 2 ; H, leg 3 ; I, leg 4 ; J, leg 5 ; K, abdomen and caudal rami ; L, margin of caudal ramus.

Basal segment of antennule with short stout pectinate setae. First two segments of antenna with large adhesion pads, third segment distally recurved and internally grooved. Distal segment of maxilla slender, as long as basal, outer process a globular spiny bulge with an anterior process, inner claw strong and serrated, median process rather short and almost of the same width throughout. Basal segment of maxilliped with prominent projecting pads, distal strong and dactyliform, distally grooved.

Basipod of first leg with three pads, first endopod segment with one pad, rami two-jointed, distal segment of endopod strongly spiny, claws on exopod stout. Basipod of second leg with one large pad, rami two-jointed (the leg in the specimen studied was abnormal). Outer part of apron of third leg with a large patch of spines, exopod three-jointed, basal segment bulging outwards, claws stout, endopod two-jointed, basal segment externally bulged. Fourth leg with one-jointed flattened sparsely denticulate rami. Fifth leg with a stout spine and three pectinate setae.

*Length.*—9.7 mm.

*Male.*—Cephalothorax comparatively longer, postero-lateral lobes apically more rounded. Lobes of second segment reaching tip of lobes of cephalothorax. Third segment transversely oblong. Fourth segment with lobe-like lateral extensions overlapping genital segment, latter squarish. Abdomen two-jointed.

Basal segment of antennule with long setae. Second segment of antenna with strong pads, third segment with long spines and a stout distal process. Maxilla more strongly armed. Maxilliped with slightly different armature.

First leg with two-jointed rami, basipod with three pads and endopod with one. Basipod of second leg with three pads, one of them double, exopod three-jointed, endopod indistinctly three-jointed. Basipod of third leg with two pads, one double, distal endopod segment modified, with a curved claw, a spiny bulge and a bifid claw. Fourth leg with indistinctly two-jointed endopod. Fifth leg with three setae and a process, sixth with a spine and a seta.

*Length.*—6.4 mm.

*Host.*—*Prionace glauca, Lamna ditrophis, L. nasus, L. cornubica, Squalus acanthias, Centrophorus granulosus, Carcharodon carcharias, Isurus oxyrhyncus, I. glaucus, Carcharhinus milberti.*

*Distribution.*—Cosmopolitan.

*Remarks.*—The exopod of the second leg of the specimen studied was only two-jointed. It shows signs of a regenerated ramus. One-seta on the caudal rami of the male also showed a curious deformity. The specimen obviously sustained an injury.

## **Echthrogaleus denticulatus** Smith
(Figs. 52 D-F, 54 L-M, 55)

*Echthrogaleus denticulatus* Smith, 1874, p. 282 ; Wilson, 1907b, p. 369, pl. 20 ; 1932, p. 428, fig. 268 ; Shiino. 1954d, p. 297, figs. 4-8 ; Cressey, 1967a, p. 56, figs. 281-290.

*Female.*—Cephalothorax roughly semicircular with faint lateral constriction and groove. Frontal plates very low. Postero-median part with three pairs of denticles, postero-lateral lobes large, distally rounded, not reaching dorsal plates of fourth segment. Second thoracic segment with large lateral lobes reaching the tip of the lobes of cephalothorax. Third segment comparatively large, narrowing backwards, hind border trilobed. Dorsal plates of fourth segment large, projecting well beyond genital segment, with antero-lateral spine, postero-laterally produced into large apically rounded lobes, hind border denticulated. Genital segment posteriorly with wide median sinus, lateral lobes very large and distally rounded, median lobe situated within the sinus, distally broader and rounded. Abdomen slightly longer than broad, partially visible in dorsal view. Caudal rami long and slender, with short setae.

Basal segment of antennule with long setae. First and second segments of antenna with large pads, third segment stout, strongly curved and distally grooved, with two spines. Maxillule with two outer spines and a stout distal tooth. Maxilla with the inner and distal processes long, latter with strong armature, extreme tip

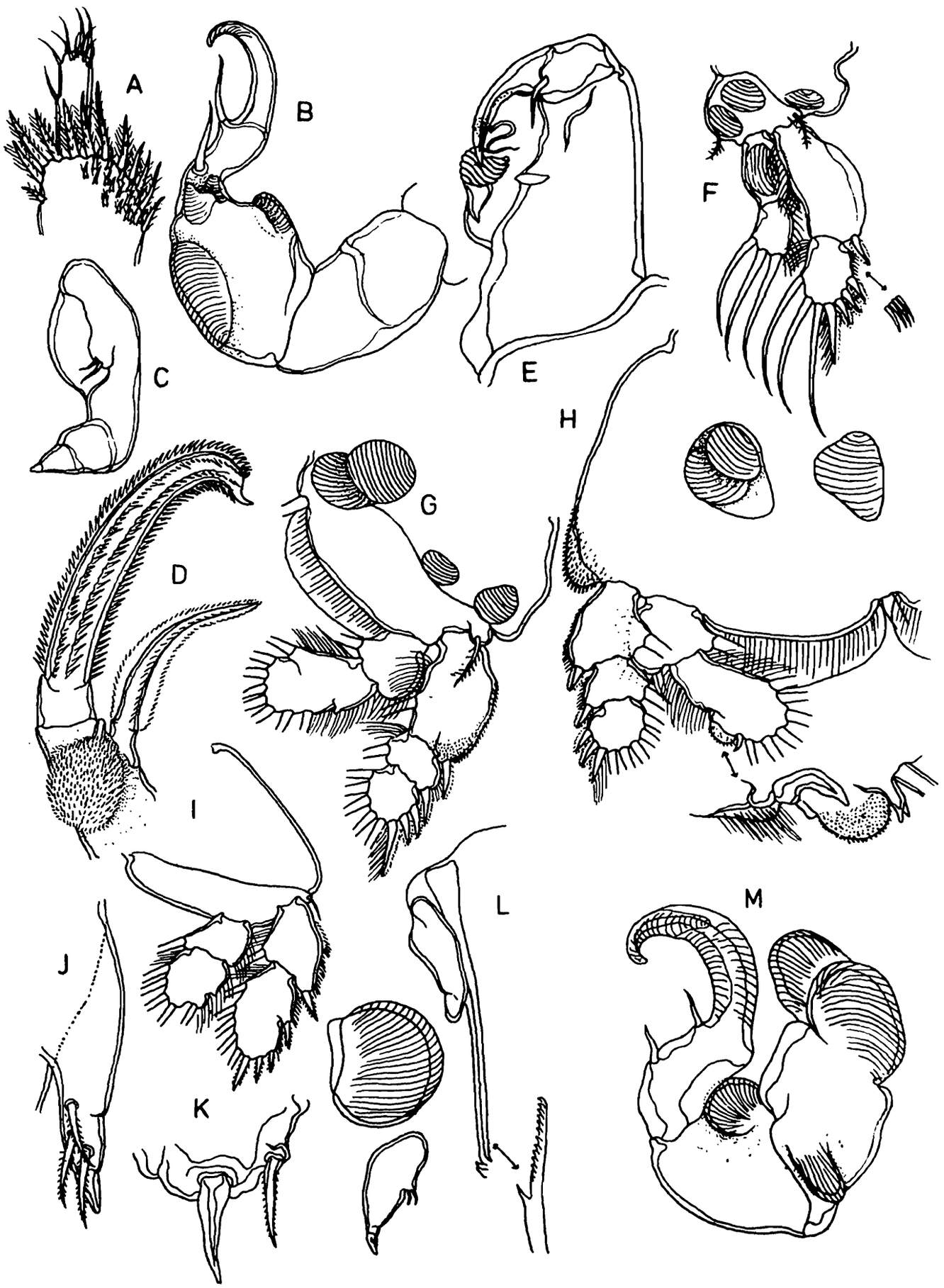


Fig. 54. A-K. *Echthrogaleus coleoptratus* (contd.). Male. A, antennule ; B, antenna ; C, maxillue ; D, maxilla ; E, maxilliped ; F-K, legs 1-6. L-M. *Echthrogaleus denticulatus* ; L, mouth tube, mandible and maxillule ; M, antenna.

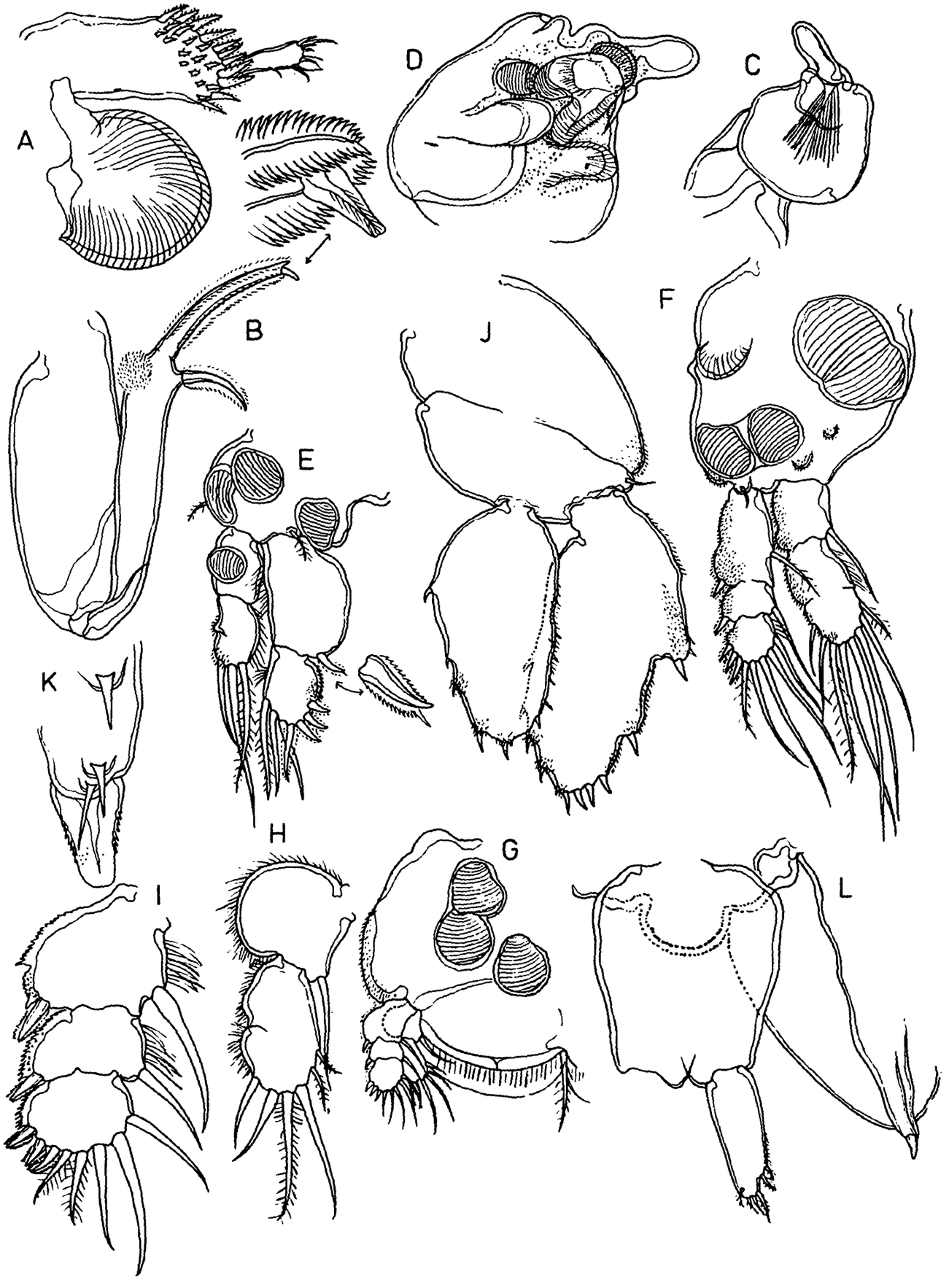


Fig. 55. *Echthrogaleus denticulatus* (contd.) ; A, antennule ; B, maxilla ; C-D, maxilliped ; E, leg 1 ; F, leg 2 ; G, leg 3 ; H, same, endopod ; I, same, exopod ; J, leg 4 ; K, leg 5 ; L, abdomen and caudal rami.

smooth and curved inwards. Basal segment of maxilliped with two adhesion pads and outer distal digitiform process, claw spatulate and asymmetrically bifid, with a strong spine.

Basipod of first leg with three large pads, rami two-jointed, basal endopod segment with one pad, that of exopod highly expanded Basipod of second leg with one single and two large double pads, exopod three and endopod indistinctly three-segmented. Apron of third leg with a single and a double pad, exopod broad, segments with serrate outer flange, endopod indistinctly three-jointed, basal segment expanded outwards. Rami of fourth leg subsimilar, one-jointed and laminate. Fifth leg a long chitinised process projecting beyond the genital segment, with three setae and a blunt process.

*Length.*—7.8 mm.

*Host.—Alopias pelagicus, A. vulpinus, Isuropsis glauca, Prionace glauca, Carcharodon carcharias, Eulamia floridanus, Sphyrna zygaena.*

*Distribution.*—Cosmopolitan.

*Remarks.—E. pellucidus* Shiino (1963) shows very close resemblance to *E. denticulatus*. According to Shiino *E. pellucidus* has transparent integument, its second and third thoracic segments are coalesced at least in the adult, the hind part of the body from the fourth segment is not longer than the anterior part, the dorsal plates of the fourth segment do not extend beyond the middle of the genital segment and are bordered with recurved spines on all sides except the front margin, the claw of the maxilliped is bifid and the first three pairs of legs are furnished with bilaterally arranged hairs instead of multiserial ones.

The single female of *E. denticulatus* described above is very much like *E. pellucidus* except for the shape of the dorsal plates of the fourth segment and the general shape of the genital segment. The genital segment of *E. pellucidus* is different in shape but it can be a sign of immaturity. I am almost sure that *E. pellucidus* is synonym of *E. denticulatus* but leave the dicision to those who have access to collections of both species.

## **Echthrogaleus pectinatus** Kirtisinghe

*Echthrogaleus pectinatus* Kirtisinghe, 1964, p. 89, figs. 105-108.

*Female.*—Cephalothorax comparatively very large, broader than long, with one lateral incision. Postero-lateral lobes short but broad. Frontal plates large and separate. Second thoracic segment laterally produced into rounded lobes. Third segment comparatively small. Fourth segment very short, with a pair of small plates, lateral and not dorsal, their hind border with about eight large teeth. Genital segment slightly broader than long, with rounded corners. Abdomen one-jointed, attached to ventral side of genital segment, but partially visible in dorsal view. Caudal rami elongate oblong, with five long setae.

Terminal segment of antenna very long and curved, with one spine. Maxilla with a short spine, a long claw and a rounded lobe. Basal segment of maxilliped with large adhesion pad, distal segment dactyliform, with a spine.

First leg with two-jointed rami, second with three-jointed exopod and two-jointed endopod. Fourth leg with indistinctly two-jointed rami.

*Length.*—6.4 mm.

*Host.—Rhincodon typus.*

*Distribution.*—Sri Lanka

*Remarks.*—This is an atypical species and Kirtisinghe's description lacks details. The shortness of the postero-lateral lobes of the cephalothorax, of the lateral lobes of the second thoracic segment and the plates of the fourth segment together with the absence of lobes on the genital segment give this species quite a distinct appearance. The plates of the fourth segment are very small but satisfy the generic definition. Unlike as in other species the rami of the fourth leg show incomplete partition.

## Genus **Phyllothereus** Norman

*Phyllothereus* Norman, 1903, p. 368 ; Yamaguti, 1963, p. 121 ; Cressey, 1967a, p. 24.

*Phyllophora* M. Edwards, 1840, p. 471.

*Laminifera* Poche, 1902, (after Cressey, 1967a).

*Parapandarus* Wilson, 1920a, p. 7 ; Yamaguti, 1963, p. 124.

*Diagnosis.*—Cephalothorax very broad, with lateral incision and backwardly directed groove, postero-lateral lobes large and conical, posterior border very short. Anterior border of cephalothorax nearly transverse, frontal plates very low. Second thoracic segment short, third fairly large, fourth indistinct, two to four with large slanting and overlapping lateral plates, those of third and fourth overlapping in the middle. Genital segment as long as broad, postero-medially prolonged into a transversely oblong plate overlapping abdomen. Abdomen similar to dorsal plate but longer. Caudal rami attached near base of abdomen, flattened, with small spines.

Antennule with spines. Antenna with long third segment. Maxilla with short processes. Claw of maxilliped dactyliform. Legs one to three with two-jointed flat rami devoid of setae, basipod of leg four very large, rami one-jointed.

Male without plates on thoracic segments. Antenna with normal third segment. Claws on mixilla longer. Legs one to four with short but broad setose two-jointed rami. Fifth and sixth legs present.

Type-species : *P. cornutus* (M. Edwards).

### **Phyllothereus cornutus** (M. Edwards)
(Figs. 56, 57, 58)

*Phyllothereus cornutus* Norman, 1903, p. 368 ; Scott, T & A, 1913, p. 92, pl. 19. figs. 11-18, pl. 23, fig. 3 ; Wilson, 1932, p. 440 ; Lewis, 1966b, p. 96, figs. 17-19 ; Cressey, 1967a, p. 25, figs. 125-138.

*Phyllophora cornuta* M. Edwards, 1840, p. 472, pl. 38, figs. 13-14.

*Parapandarus nodosus* Wilson, 1924a, p. 7.

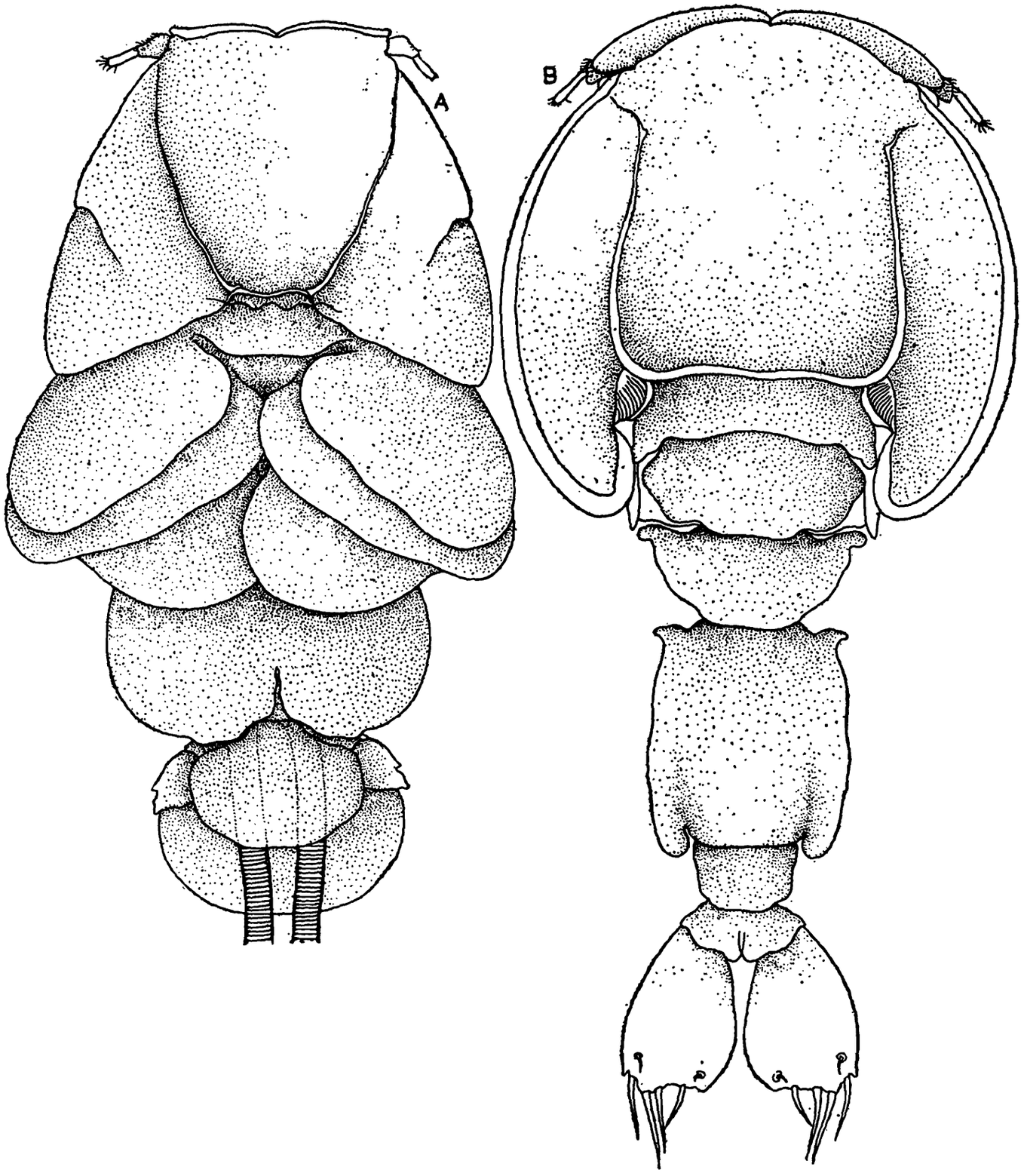


Fig. 56. *Phyllothereus cornutus* (M. Edwards) : A, female, dorsal view ; B, male, dorsal view.

*Female.*—General shape of body as given in the generic definition. Basal segment of antennule large, with strong spines instead of setae, distal segment elongated. First two segments of antenna

Fig. 57. *Phyllothereus cornutus* (contd.) : Female. A, antennule ; B, antenna ; C, maxillule ; D, maxilla ; E, same, tip enlarged ; F, maxilliped, G-J, legs 1-4 ; K, legs 5 and 6, abdomen and caudal ramus.

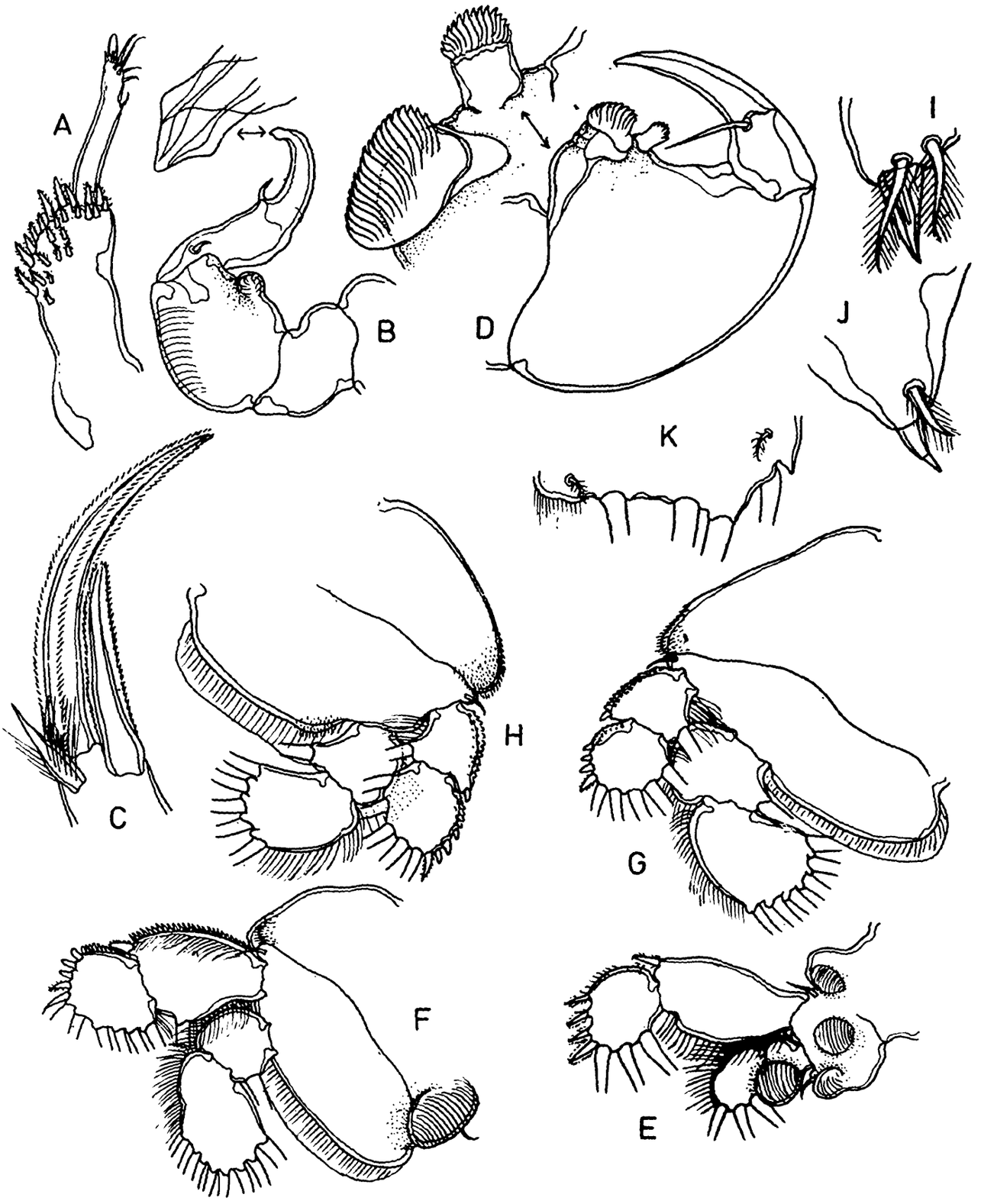


Fig. 58. *Phyllothereus cornutus* (contd.) ; Male. A, antennule ; B, antenna ; C, maxilla ; D, maxilliped ; E-J, legs 1-6 ; K, tip of caudal ramus.

very short, third very long and strongly curved, with two small spines. Maxillule with a proximal bunch of one spine and two setae, distally a small spine and a stout process. Basal segment of maxilla stout, partially fused with distal segment, latter with outer pectinate short process drawn out into a sharp spine, inner spine stout and bilaterally serrated, median process with characteristically arranged spinules, inner process with a basal crest of spines. Basal segment of maxilliped with a circular projecting disc, claw narrow and dactyliform, with a slender spine.

Basipod of first leg with a small adhesion pad, a similar pad on basal segment of endopod, second endopod segment with three curved claws, distal exopod segment with four spines and three claws. Basipod of second leg with three spiny pads and a small corrugated pad, rami highly flattened and prominently spinulose, armed with very short spines. Basipod of third leg ventrally produced into a spiny lobe, rami two-jointed and flattened, endopod longer. Basipod of fourth leg anteriorly produced into a very large, semicircular lobe with spiny border, rami subsimilar, one-jointed.

*Length.*—10.3 mm.

*Male.*—Cephalothorax evenly rounded, with incurving postero-lateral lobes reaching the middle of the third segment, frontal plates prominent. Second thoracic segment postero-laterally produced into a narrow apically blunt lobe, third segment forming rounded lobes. Fourth segment antero-laterally drawn out into apically curved blunt lobes, narrowing backwards, hind border convex. Genital segment longer than broad, with small curved antero-lateral corners and rounded postero-lateral lobes. Abdomen two-jointed, segments broader than long, first longer. Caudal rami with four large and two small setae. The shape of the thoracic segments and genital segment is very characteristic.

Antennule more slender than in female. Antenna with shorter third segment, apex converted into a triangular lobe, second segment fairly stout, with two corrugated pads. Claws of maxilla longer. Basal segment of maxilliped with two projecting strongly corrugated pads, distal segment stout and dactyliform, with a long spine.

Basipod of first leg with three adhesion pads, first segment of endopod internally expanded and slightly overlapping second segment and carrying a pad, first segment of exopod elongated. Basipod of second leg with one pad, rami two-jointed, exopod larger and externally spiny. Basipod of third leg without pad, exopod smaller than endopod, externally more conspicuously spiny. Fourth leg similar to third but slightly smaller. Fifth leg composed of two setae and a strong spine. Sixth formed of one stout seta and one stout spine.

*Host.—Prionace glauca.*

*Distribution.*—Cosmopolitan

*Remarks.*—The synonymy of this species, until Cressey clarified it, was most complicated. This is indeed surprising since of all the pandarids this species, both male and female, has very diagnostic characters.

## Genus **Gangliopus** Gersteacker

*Gangliopus* Gerstaecker, 1854, p. 189 ; Yamaguti, 1963, p. 120 ; Cressey, 1967a, p. 27.

*Diagnosis.*—Cephalothorax broader than long, postero-laterally expanded into large triangular lobes making the hind border deeply concave. Lateral sides with a median incision and faint transverse groove. Frontal plates low, subventral. Dorsal plates of second thoracic segment comparatively small, situated wide apart, plates of third segment larger, fused in the middle, plates of fourth segment large, fused and with deep posterior incision. Plates of second and third segments slanting outwards, all the plates successively overlapping. Genital segment comparatively small, with broad posterior sinus housing the abdominal plate, lobes of genital segment rounded. Abdomen one-jointed and laterally drawn out, distally evenly rounded. Caudal rami with three spines and two setae.

Antennule without and antenna with basal pad. Maxilla with three processes. Maxilliped with inner distal process, distal segment

dactyliform. Legs one to three with two-jointed, slender, strongly spiny rami without setae, basipod with spiny pad, rami of fourth leg one-jointed. Fifth leg present.

Cephalothorax of male elongated, with projecting frontal plates and long postero-lateral lobes. Thoracic segments two to four subequal in size, first laterally produced into lobes, third laterally angular, fourth antero-laterally forming small rounded lobes, its hind border convex. Genital segment as long as broad, with postero-lateral lobes. Abdomen two-jointed.

Antennule and antenna with pads. Maxilliped with additional armature. Legs one to four with two-jointed setose rami, basipods with modified fleshy pads.

Type-species : *G. pyriformis* Gerstaecker.

*Discussion.*—Three species, *G. pyriformis* Gerstaecker (1854), *G. tetrapturi* Yamaguti and Yamasu (1960) and *G. japonicus* Shiino (1960a) have been described under this genus. *G. tetrapturi* is a synonym of *G. pyriformis* and Cressey removed *G. japonicus* to the new genus *Pannosus* Cressey (1967a).

*Gangliopus* shows very close resemblance to *Phyllothereus* in the shape of the body of both sexes. But the legs show clear difference particularly in the case of the females.

### **Gangliopus pyriformis** Gerstaecker
(Figs. 59-60)

*Gangliopus pyriformis* Gerstaecker, 1854, p. 192 ; Wilson, 1907b, p. 350 ; Monod and Dollfus, 1938, p. 204 ; Yamaguti, 1963, p. 120 ; Cressey, 1967a, p. 28, figs. 139-146.

*Gangliopus tetrapturi* Yamaguti and Yamasu, 1960, p. 142 ; Yamaguti, 1963, p. 121, pl. 141, fig. 1.

*Female.*—General shape of body as in the generic definition. Antennule stout, basal segment with blunt spines. Basal segment of antenna with a pad, third segment large, narrowing and distally curved. Maxillule somewhat rectangular, with two outer setae and

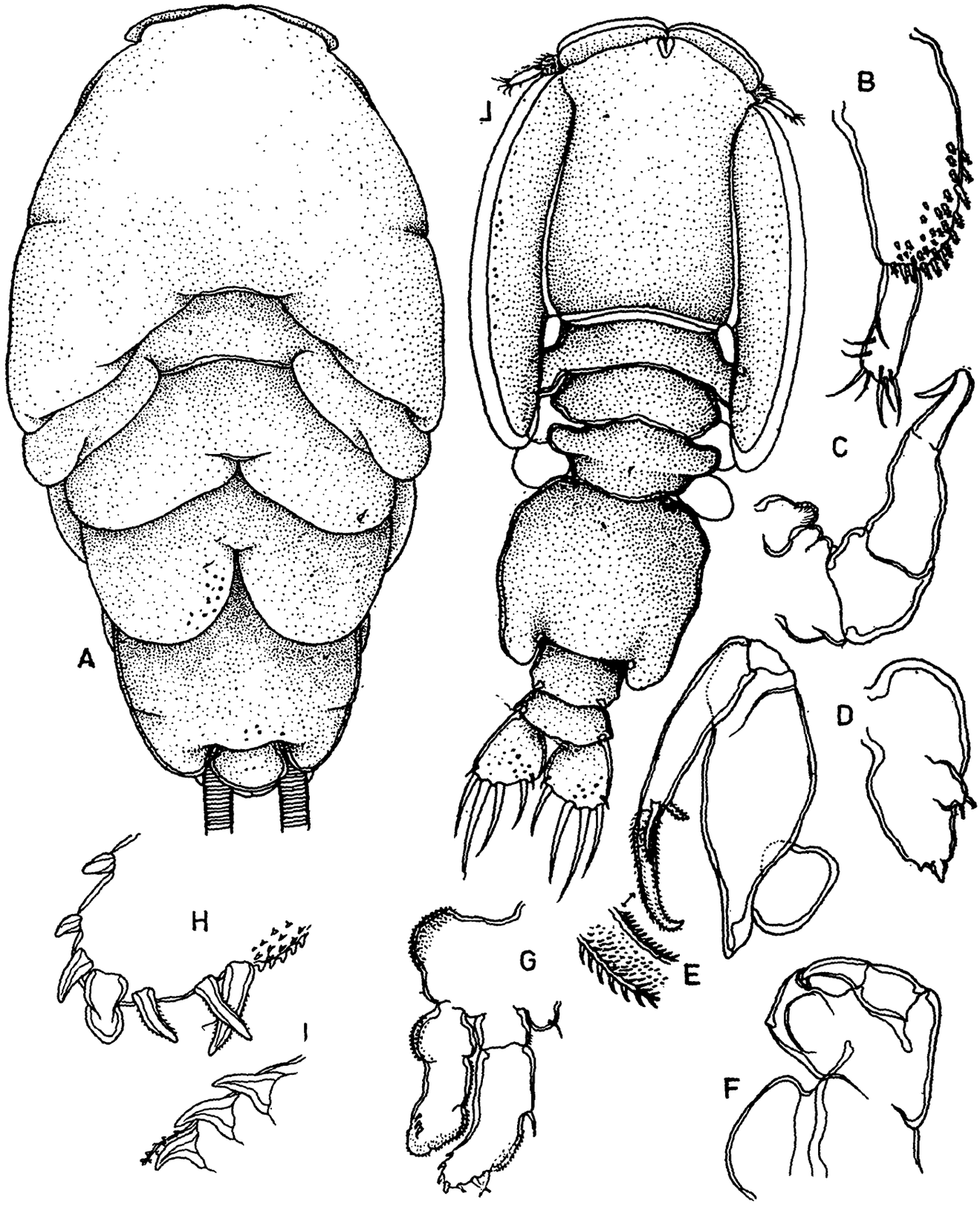


Fig. 59. *Gangliopus pyriformis* Gerstaecker ; Female. A, female, dorsal view ; B, antennule ; C, antenna ; D, maxillule ; E, maxilla ; F, maxilliped ; G, leg 1 ; H, same, tip of endopod ; I, same, tip of exopod. J, Male, dorsal view.

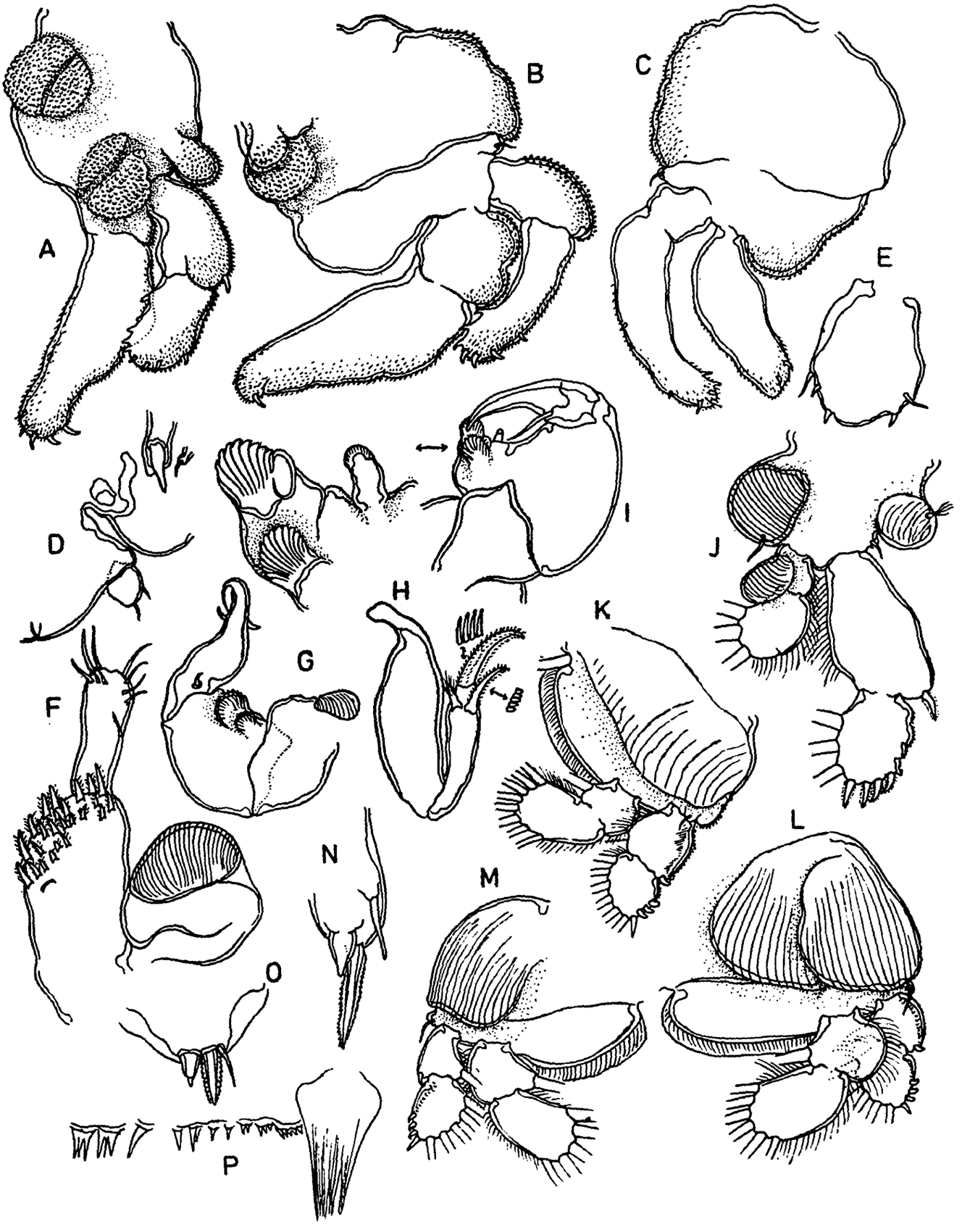


Fig. 60. *Gangliopus pyriformis* (contd.) : A-E, Female. A-C, legs 2-4 ; D, legs 5-6, abdomen and caudal ramus ; E, caudal ramus. F-P, Male. F, antennule ; G, antenna ; H, maxilla ; I, maxilliped ; J-O, legs 1-6 ; P, spines on ventral side of genital segment.

one small and one large distal teeth. Basal segment of maxilla stout, associated with a pad, outer process of distal segment pectinate, inner slender, middle process stout and covered with spines. Basal segment of maxilliped internally expanded into a large lobe with distal excavation, distal segment dactyliform, closing into the concavity.

Basipod of first leg with spiny dorsal lobe, rami two-jointed, spiny and armed with short claws, one claw very blunt. Basipod of second leg with three spiny pads, two of them double, rami elongated and two-jointed, strongly spiny. Basipod of third leg enlarged, with a spiny dorsal lobe and double ventral pad, rami two-jointed, exopod narrow, endopod longer and broader. Basipod of fourth leg slightly smaller than that of third, without pad, rami slender, exopod longer and indistinctly two-jointed, endopod one-jointed. Fifth and sixth legs as shown in figure.

*Length.*—9.0 mm.

*Male.*—Body as described under genus. Genital segment with anterior ventral transverse row of spines as illustrated. Antennule comparatively stout, associated with a large grooved double pad. Antenna with pads on first and second segments, third segment with two small spines. Basal segment of maxilliped with two corrugated pads on a high process followed by a very small process, distal segment dactyliform.

Basipod of first leg with two pads, produced dorsally and ventrally, basal segment of endopod with a pad, first exopod segment large. Basipod of second leg with large, muscular, projecting and faintly grooved pad, rami subequal, two-jointed. Basipod of third leg larger than that of second, rami two-jointed, endopod larger than exopod. Fourth leg similar to third but much smaller. Fifth leg composed of a seta, a flanged spine and a blunt process. Sixth leg similar to fifth but seta and spines smaller.

*Length.*—7.3. mm.

*Host.*—*Prionace glauca, Isurus nasus, Tetraptur mitsukuri.*

*Distribution.*—Cosmopolitan.

*Remarks.*—Cressey has shown the fifth leg as a process carrying a setule. But external to the spine is a seta mounted on a tubercle. These may represent the fifth and sixth legs. He has illustrated the dorsal plates of the fourth segment as laterally extending beyond those of the third. The reverse is true of the specimen I studied. There is difference in the armature of the maxilliped of the male also.

As already observed *Gangliopus* closely resembles *Phyllothereus*. Both have the same type of body and cephalic appendages. There is a general reduction in the pads and increase in spinulation of the legs. The males have almost identical legs. As pointed out by Cressey the similarity is the result of adaptation to life on the gill filaments.

The adhesion pads on the legs of the female of *Gangliopus* are of a peculiar type, projecting and studded with spines or pustules. The surface is traversed by a deep groove whose edges project. The legs are indeed of a unique type different from those of all other pandarids.

## Genus **Dinemoura** Latreille

*Dinemoura* Latreille, 1829, p. 197 ; Yamaguti, 1963, p. 116 ; Cressey, 1967a, p. 38.

*Dinematura* Burmeister, 1835, p. 284 ; Lewis, 1966b, p. 102.

*Diagnosis.*—Cephalothorax broad, lateral borders with one or more pairs of constrictions, postero-lateral lobes large, reaching lateral lobes or dorsal plates of fourth segment. Frontal plates separate. Second thoracic segment laterally and third posteriorly produced into lobes. Fourth segment with dorsal plates, or lateral lobes. Genital segment large, posteriorly bilobed. Abdomen projecting beyond genital segment, two-jointed, each segment with a dorsal plate. Caudal rami laminate, terminal.

Antennule with double adhesion pad, if present. Antenna with several pads. Maxillule with three basal spines and a distal process. Maxilla with two long claws, with combs of spinules and a bunch

of hairs (armature may be elaborate). Basal segment of mixilliped with strong pads, distal dactyliform.

First pair of legs with two-jointed rami, second and third legs with three-jointed rami, rami broad and characteristically armed, Fourth leg small, with one-jointed rami. Basipod of legs one to three with adhesion pads.

Fourth thoracic segment of male with small lateral lobes. Abdomen two-jointed. Legs with two-jointed rami, endopod of leg three modified.

Type-species : *D. producta* (Muller).

*Discussion.*—Yamaguti listed ten species under this genus but Cressey reduced them to four, namely, *D. latifolia* (Stp. & Lutk. 1861), *D. descrepans* Cressey (1967a), *D. ferox* (Kroyer, 1838) and *D. producta* (Muller, 1785).

*Key to species of* **Dinemoura**

1. Dorsal plates of fourth segment large, projecting beyond lateral borders of genital segment, posterior lobes of genital segment distally rounded ..... *.latifolia* (Stp. & Lutk.)
— Dorsal plates of fourth segment small, not projecting beyond lateral borders of genital segment, posterior lobes of genital segment distally truncate ..... *.descrepans* Cressey

## **Dinemoura latifolia** (Stp. & Lutk.)
(Figs. 61A, 62)

*Dinematura latifolia* Stp. & Lutk., 1861, p. 378, pl. 8, fig. 16 ; Wilson, 1907b, p. 383, pls. 24-25 ; Yamaguti, 1936c, p. 9, pl. 5, figs. 50-52 ; Shiino, 1954d, p. 308, figs. 9-10 ; Lewis, 1966b, p. 102, figs. 20-23.

*Dinemoura latifolia* Yamaguti, 1963, p. 117, pl. 136, fig. 1 ; Cressey, 1967a, p. 42, figs. 194-196 ; Hewitt, 1967b, p. 195, figs. 21-43.

*Female.*—Cephalothorax broader than long, with two pairs of rather low lateral constrictions. Frontal plates of average size, separate, postero-lateral lobes rather large, equally broad throughout. Second thoracic segment laterally expanded, third drawn out

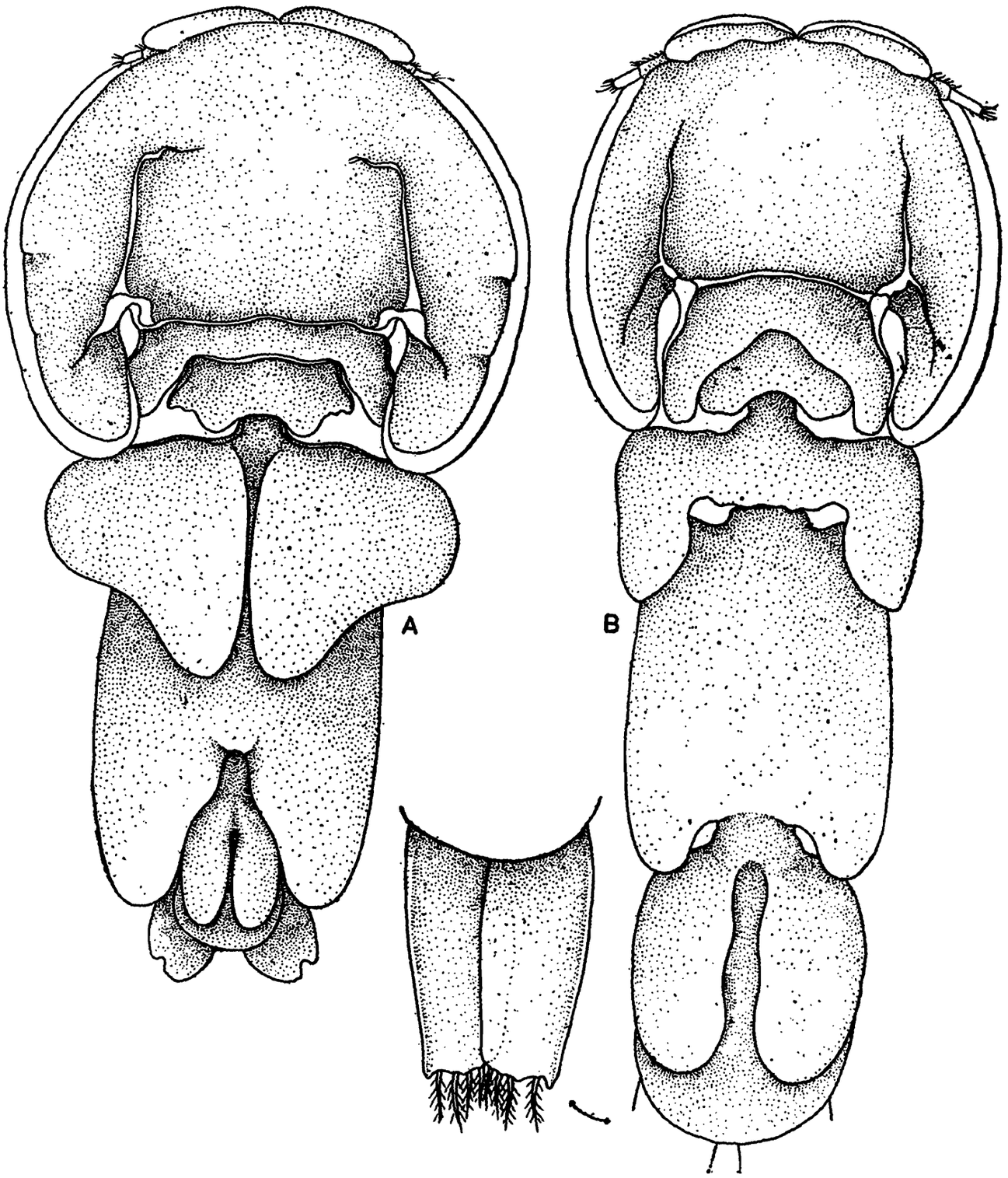


Fig. 61. A, *Dinemoura latifolia* (Stp. & Lutk.), female, dorsal view : B, *Pagina tunica* Cressey, female, dorsal view.

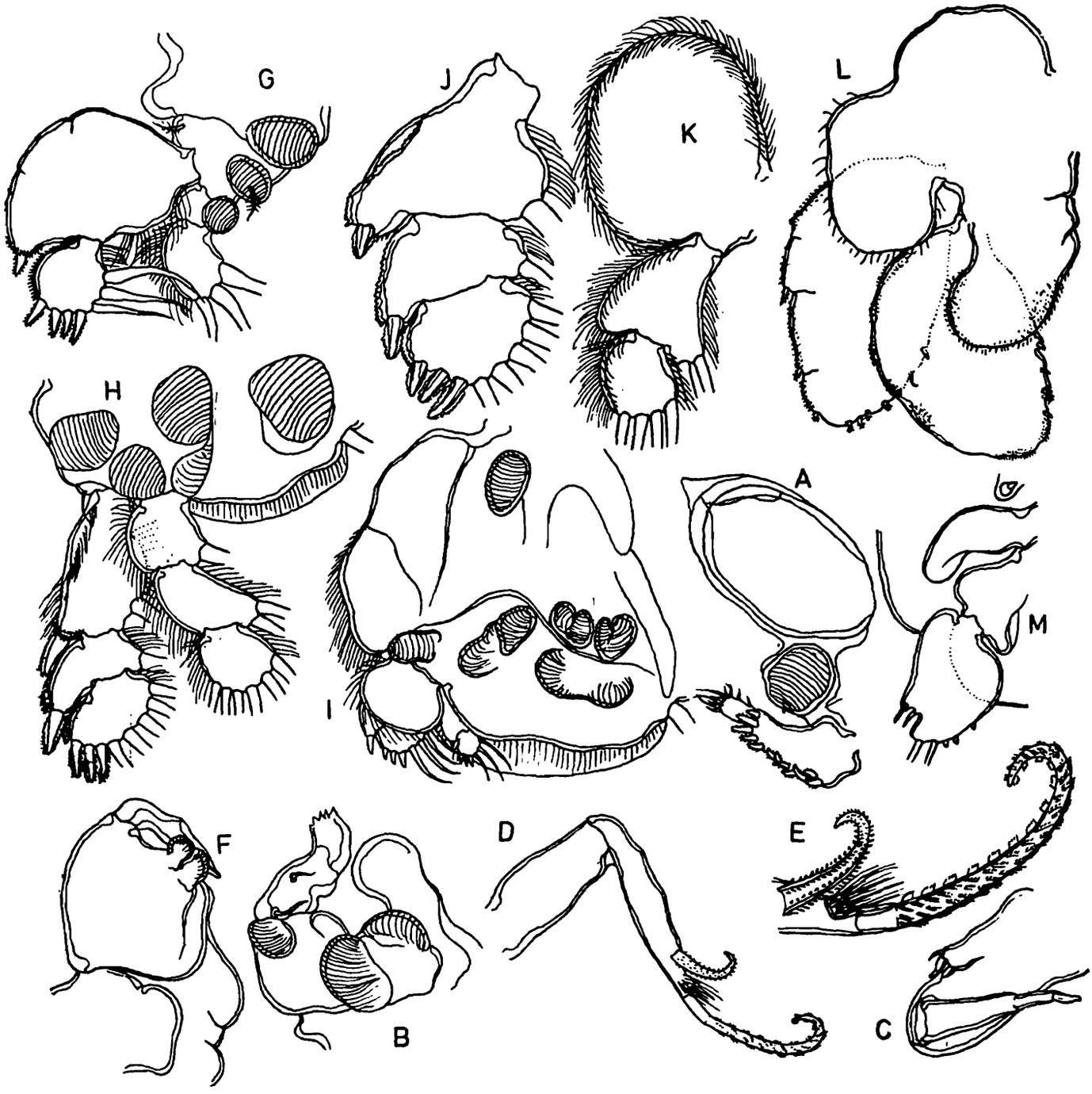


Fig. 62. *Dinemoura latifolia* (contd.) : A, antennule ; B, antenna ; C, maxillule ; D, maxilla ; E, same, tip enlarged ; F, maxilliped ; G, leg 1 ; H, leg 2 ; I, leg 3 ; J, same, exopod ; K, same, endopod ; L, leg 4 ; M, abdomen and caudal ramus.

into small lateral and posterior lobes. Fourth segment with large dorsal plates covering nearly half of the genital segment, laterally expanded into broad lobes reaching far beyond the sides of the genital segment and posteriorly produced into rounded lobes. Genital segment deeply cleft, with a bilobed median plate within the sinus. Abdomen two-segmented, basal segment short and

laterally drawn out into curved rounded lobes, distal segment large, distally forming an elegantly rounded semicircular lobe. Caudal rami laminate, reaching beyond the body, with long setae.

Antennule comparatively small, associated with a large, bilobed pad, anterior lobe small. First and second segments of antenna with prominent adhesion pad, third segment robust (broken in the specimen examined). Maxillule with basal projection carrying a spine and two setae, distal process long and jointed. Distal segment of maxilla longer than basal, outer process represented by a bunch of stiff hairs mounted on a tubercle, inner and median claws slender and strongly curved, latter much longer, with combs of spinules covering the whole surface. Basal segment of maxilliped with two inner distal semicircular pads, claw narrowing, not curved.

Basipod of first leg with two pads, basal segment of endopod with one pad, basal segment of exopod highly enlarged, rami two-jointed. Basipod of second leg with four pads, one double, rami three-jointed, exopod stouter and strongly armed. Basipod of third leg with six to seven pads, some of them double, basal segment of exopod externally produced, basal segment of endopod forming a large hairy lobe, both rami highly flattened. Basipod of fourth leg produced into a posterior, an anterior and a distal lobe, rami one-jointed and highly flattened. Fifth leg a small spine, sixth a chitinised lobe.

*Length.*—14.0 mm.

*Host.—Isurus oxyrhynchus, Lamna nasus, L. ditrophis, Prionace glauca, Carcharodon rondelettii, C. carcharias, Alopias vulpinus, Galeorhinus australis.*

*Distribution.*—Cosmopolitan.

*Remarks.*—In all the descriptions of this species the anterior part of the basipod of the fourth leg is shown as folded downwards which appears to be its natural condition. I have illustrated it as spread out and this gives the appendage quite a different appearance.

## **Dinemoura descrepans** Cressey
(Figs. 63, 64, 65, A-F.)

*Dinemoura descrepans* Cressey, 1967a, p. 43, figs. 197-217.

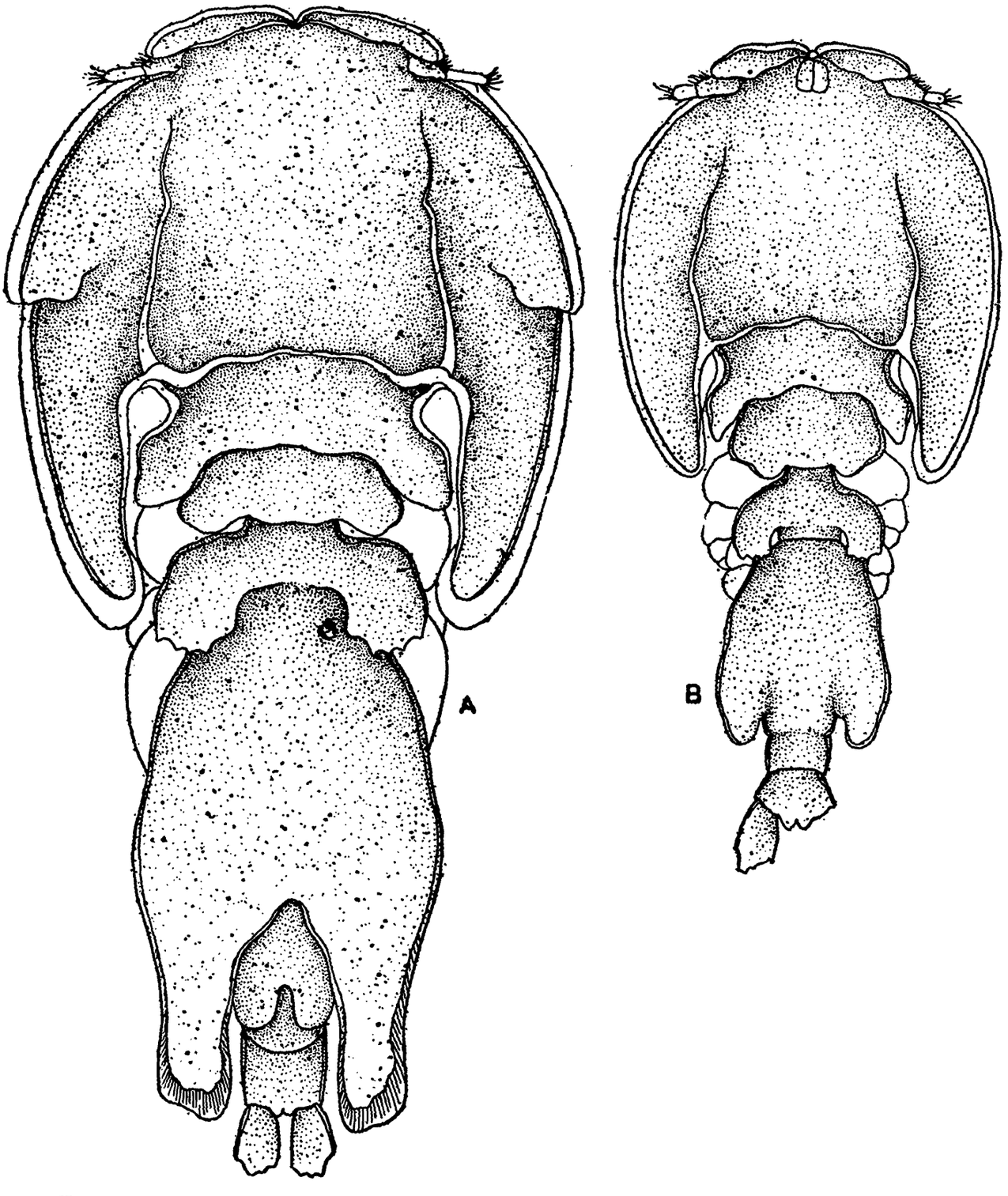


Fig. 63. *Dinemoura descrepans* Cressey ; A, female, dorsal view ; B, male, dorsal view.

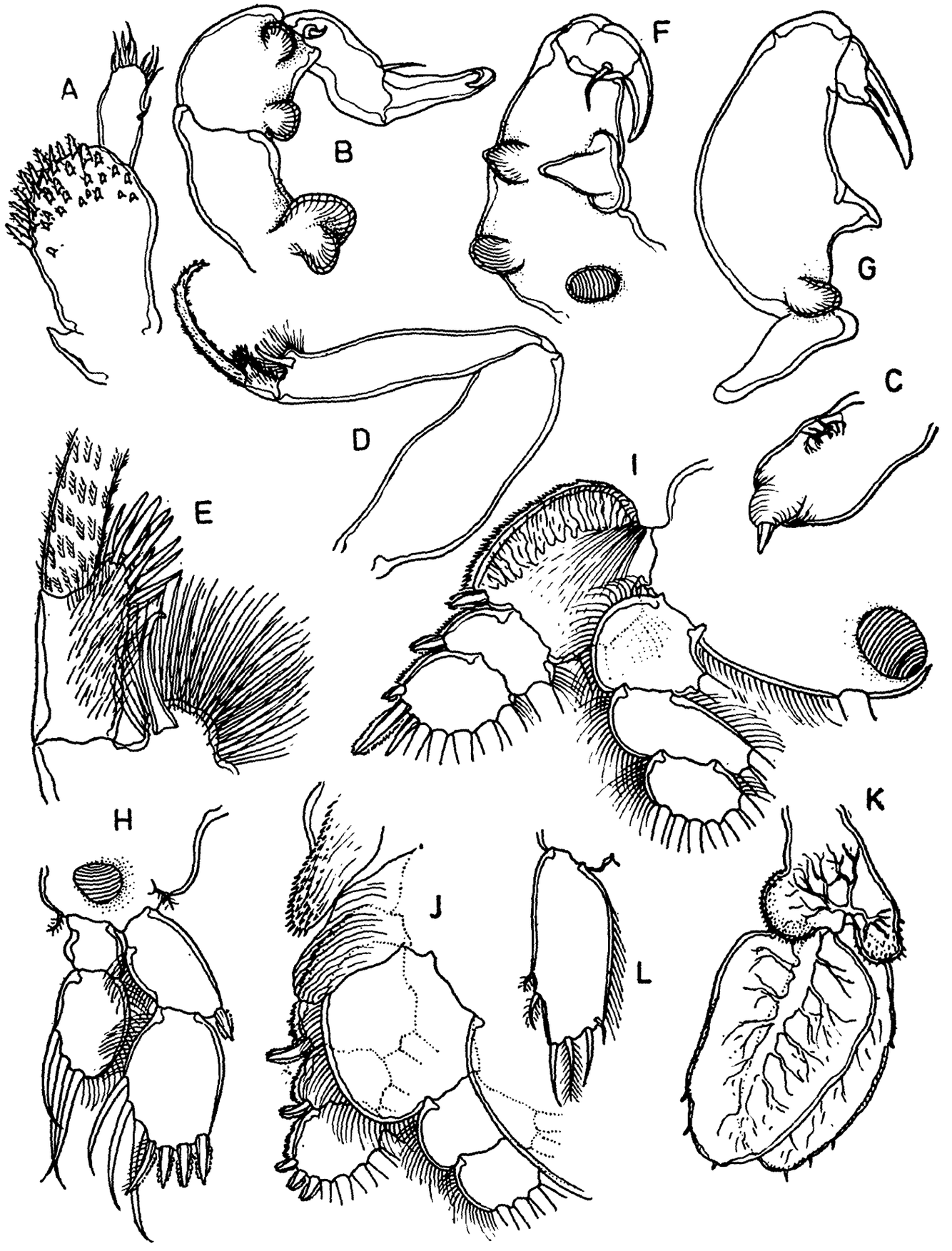


Fig. 64. *Dinemoura descrepans* (contd.) : Female. A, antennule ; B, antenna ; C, maxillule ; D, maxilla ; E, same, distal part enlarged ; F-G, maxilliped ; H-K, legs 1-4 ; L, caudal ramus.

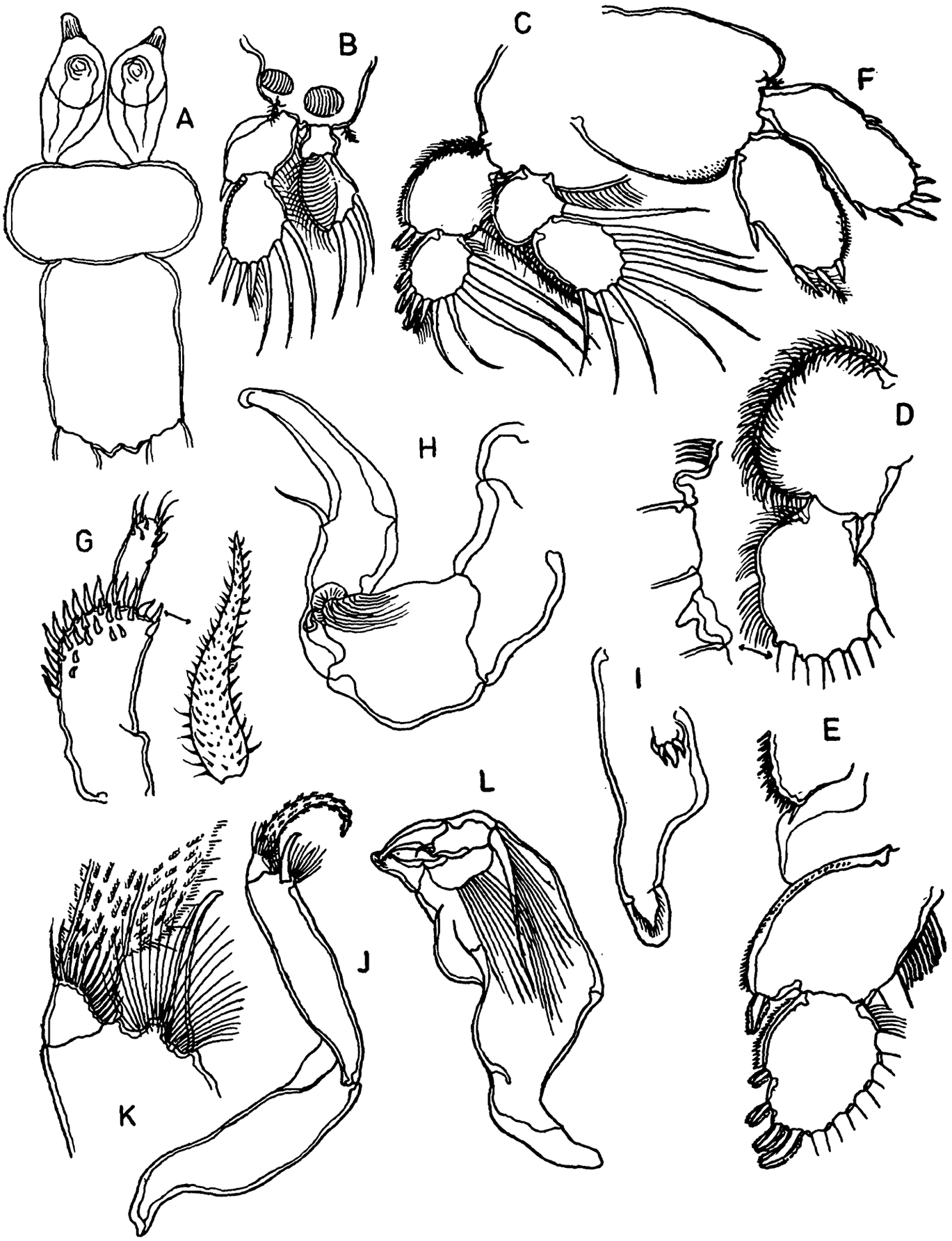


Fig. 65. *Dinemoura descrepans* (contd.): A, genital segment and abdomen, female ; B-F, male : B, leg 1 ; C, leg 4 ; D, leg 3, endopod; E, same, exopod ; F, leg 4 ; G-L, *Pagina tunica* (contd.) : G, antennule ; H, antenna ; I, maxillule ; J, maxilla ; K, same, tip enlarged ; L, maxilliped.

*Female*.—Cephalothorax nearly twice as broad as long, with a prominent lateral incision continued as an oblique groove. Frontal plates projecting. Postero-lateral lobes of cephalothorax comparatively narrow, not reaching the genital segment. Thoracic segments two to four subequal in length, second produced into large irregular lobes, third into short lobes. Dorsal plates of fourth segment very small, situated laterally, their hind border with four teeth. Genital segment nearly equal in length and width, postero-laterally produced into roughly parallel sided, apically subtruncate lobes overreaching the abdomen. Median plate nearly circular, with fairly broad incision about half the length of the plate. Abdomen two-jointed, basal segment transversely oblong, distal segment longitudinally rectangular. Caudal rami elongate oblong, with four long and two small setae.

Basal segment of antennule stout, with several blunt pectinate spine-like setae. Basal segment of antenna elongated, with a double pad, second segment with two pads, third segment proximally stout, with two spines, apex recurved. Maxillule with three small basal setae and a stout distal process. Distal segment of maxilla with elaborate armature. Distal inner part of distal segment with a rounded prominence carrying a bunch of stiff hairs and a curved process, basal part of median process pectinate, its inner distal part produced and carrying a bunch of flattened spines, claw armed as usual in the genus. Basal segment of maxilliped elongated, with large conical inner median process and three pads, distal segment narrowing, only very slightly curved.

Basipod of first leg with a pad, rami two-jointed, exopod larger, its second segment larger than first. Basipod of second leg with a pad, rami three-jointed, exopod larger, its basal segment much enlarged, outer border of exopod with spiny flange. Basipod of third leg above the insertion of the exopod prominently spiny, first segment of exopod smaller than that of second leg, basal segment of endopod highly expanded. Basipod of fourth leg very small, distally forming an outer and inner spiny lobe, rami one-jointed, lamellar, with branching canals inside, endopod broader than exopod.

*Length*.—13.5 mm.

*Male.*—Cephalothorax nearly as in the female, frontal plates more projecting. Third thoracic segment larger. Lateral plates of fourth segment small, just overlapping genital segment. Genital segment with small antero-lateral and large postero-lateral rounded lobes, postero-medially produced to give attachment to the two-segmented abdomen.

Basipod of first leg with two small pads, distal segment of endopod with one large pad, exopod larger than endopod. Rami of second leg two-jointed, exopod slightly larger. Basipod of third leg spiny above the insertion of the exopod, basal segment of exopod produced at the outer distal part, second segment of endopod with two small projecting lobes as in figure. Basipod of fourth leg as long as the one-jointed rami, exopod longer but narrower than endopod.

*Length.*—9.0 mm.

*Host.—Alopias vulpinus, A. superciliosus.*

*Distribution.*—Indian and Pacific Oceans (Madagascar).

*Remarks.*—The above description is based on a male and a female sent by Dr. Cressey. But I find several variations from the description given by Cressey. The frontal plates of the female are less exposed, the postero-lateral lobes of the cephalothorax curve inwards and the distal border of the genital processes is different. The process on the basal segment of the maxilliped is more prominent than shown by Cressey. Cressey has shown the exopod of the third leg as curving outwards which is not true of my specimen, the basipod is more elaborately spiny.

The single male available shows much difference. Probably it is immature. The posterior part of the genital segment is totally different in shape and the abdomen is comparatively shorter but stouter. In *Dinemoura* legs one to three of the male are like those of the female except that the third endopod segment of leg three is modified. Leg four has two-jointed rami. In the male sent by Dr. Cressey legs one to three have two-jointed rami and leg four one-jointal rami. The endopod of the third leg is not modified.

Probably the male does not belong to *Dinemoura* at all. It is however described.

## Genus **Pagina** Cressey

*Pagina* Cressey, 1964, p. 285 ; 1967, p. 49.

*Diagnosis.*—Cephalothorax broader than long, frontal plates low but separate, postero-lateral lobes large, just stopping short of the dorsal plates of fourth segment. Second thoracic segment laterally drawn out into posteriorly directed large lobes contacting the dorsal plates of the fourth segment. Third segment as long as second, lateral extensions short. Dorsal plates of fourth segment large, laterally situated, slightly overlapping genital segment. Genital segment as long as broad, with large rounded postero-lateral lobes and postero-medially produced to meet the abdomen. Abdomen two-jointed, first segment small and rounded, with a pair of almost separate longitudinally oblong dorsal plates, second segment broadening backwards, with a nearly circular dorsal plate. Caudal rami large, flattened and nearly rectangular, with long distal setae.

Cephalic appendages generally as in *Dinemoura*. Leg one with two-jointed rami, legs two to four with three-jointed rami.

Male typically pandarid, without dorsal plates. Appendages as in female.

Type species : *P. tunica* Cressey.

*Discussion.*—This genus is closest to *Dinemoura*. The curious modification of the maxilla is found in an identical fashion in *D. descrepans* Cressey. In both genera the third segment of the endopod of the third leg of the male is modified.

### **Pagina tunica** Cressey
(Figs. 61B, 65 G-L, 66)

*Pagina tunica* Cressey, 1964, p. 285, figs. 1-25 ; 1967a, p. 50, figs. 243-267.

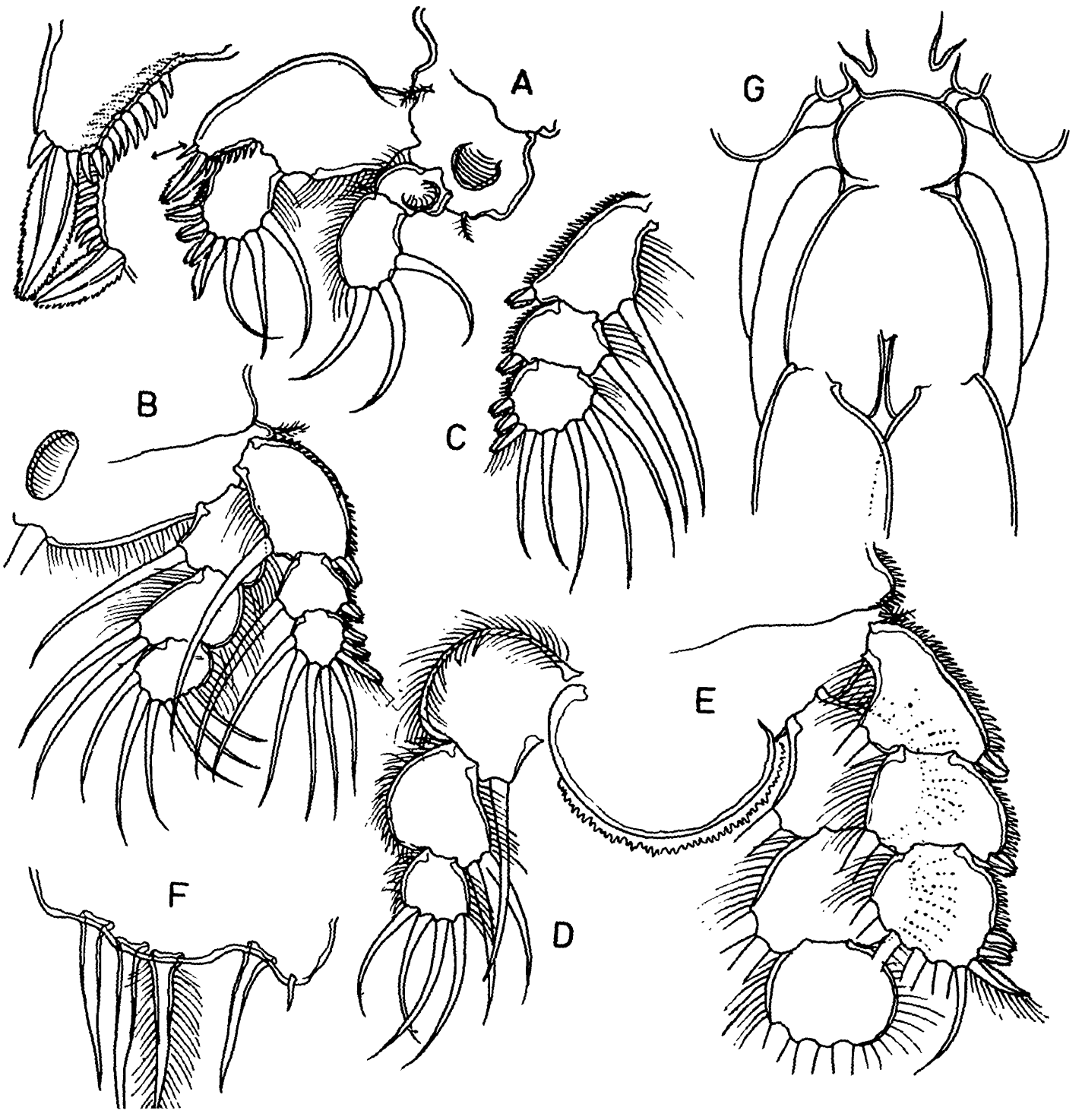


Fig. 66. *Pagina tunica* (contd.) : A, leg 1 ; B, leg 2 ; C, leg 3, exopod ; D, same, endopod ; E, leg 4 ; F, tip of caudal ramus ; G, abdomen and caudal rami.

*Female*.—Body as described under the genus. Basal segment of antennule with several setae, each seta covered all over with setules as shown in the figure. Basal segment of antenna elongated, second segment with outer distal pad, third segment with basal

short spine and median long spine, apex recurved. Maxillule with three proximal setae and a stout blunt distal process or lobe. Basal segment of maxilla similar to distal in size, distal segment with inner distal projection carrying a cluster of stiff hairs and a long process, distal claw strongly curved, basally with an arc of spines and the surface covered with combs of spinules exactly as in *D. descrepans*. Maxilliped long and cylindrical, its inner distal part produced into a digitiform process against which the short slightly curved dactyliform second segment closes producing a subchela.

Basipod of leg one with a pad, basal segment of endopod with a pad, exopod much larger, first segment produced at the outer distal part, its lower border with a row of sharp teeth overlapping a similar row of teeth on second segment, claws with broad serrate flange. Basipod of leg two with a pad, rami three-jointed, basal segment of exopod comparatively large. Rami of third leg three-jointed, exopod smaller than endopod, basal segment of endopod enlarged. Ventral part of basipod of fourth leg expanded into a semicircular lobe, rami clearly three-jointed and subequal in length and width, outer border of exopod spiny and that of endopod hairy.

*Length.*—17.0 mm.

*Male.*—Cephalothorax as in female, frontal plates confluent, postero-lateral lobes comparatively short, not reaching the tip of the lateral lobes of second segment, latter not reaching the tip of those of third. Fourth segment with small lateral lobes. Genital segment as long as broad, postero-laterally angular. Abdomen fairly long, second segment not enlarging. Caudal rami narrow.

Second segment of antenna with prominent pads, third basally broad, distally curved. Process on basal segment of maxilliped low, followed by a pad. Legs as in female but last endopod segment of leg three modified.

*Length.*—11.7 mm.

*Host.—Alopias superciliosus.*

*Distribution.*—Madagascar, Pacific.

## Family TREBIIDAE

*Diagnosis.*—Cephalon fused with first and second thoracic segments to form a cephalothorax, segments three and four free. Frontal plates without lunules. Genital segment moderately swollen, with or without spines. Abdomen one-to three-segmented, often spiny. Caudal rami elongated, often spiny. Egg tubes as in Caligidae. Antennule and antenna as in Caligidae, third segment of antenna long and falcate, first segment without process. Cephalic appendages generally as in *Caligus*. Sternal fork present. Legs one to four biramous, rami of first pair two-jointed, endopod comparatively small, those of others three-jointed, endopod of fourth small and two-jointed.

Type genus : **Trebius** Kroyer.

### Genus **Trebius** Kroyer

*Trebius* Kroyer, 1838, p. 30 ; Wilson, 1907a, p. 672 ; Shiino, 1954a, p. 247 ; Yamaguti, 1963, p. 130 ; Hameed and Pillai, 1973a, p. 461.

*Diagnosis.*—Same as that of family. Male showing the same type of dimorphism as in Caligidae.

Parasites of elasmobranchs.

Type species : *T caudatus* Kroyer.

*Discussion.*—Yamaguti listed seven species, namely, *T caudatus* Kroyer (1838), *T akajeii* Shiino (1954a), *T bilobatus* Brian (1912), *T exilis* Wilson (1906), *T latifurcatus* Wilson (1921), *T longicaudatus* Shiino (1954a) and *T tenuifurcatus* Rathbun (1887). Hameed and Pillai (1973a) added three more species. Only four species have so far been recorded from Indian waters.

#### *Key to species of* **Trebius**

| | | |
|---|---|---|
| 1. | Abdomen longer than genital segment | ..2 |
| — | Abdomen shorter than genital segment | .3 |
| 2. | Abdomen three-segmented | *sepheni* Hameed and Pillai |
| — | Abdomen two-segmented | *kirtii* Hameed and Pillai |

3. First segment of abdomen longer than second ..... *.exilis* Wilson
— First segment of abdomen not longer than second ..... *javanicus* Hameed and Pillai

## **Trebius exilis** Wilson
(Fig. 67 A-J)

*Trebius exilis* Wilson, 1906, p. 194, pl. 2, figs. 20-23 ; 1907a, p. 678, pl. 15. figs. 1-7 ; Yamaguti, 1963, p. 130, pl. 152, fig. 1; Kirtisinghe, 1964, p. 77 ; Hameed and Pillai, 1973a, P. 462 figs. 1-14.

*Female.*—Cephalothorax slightly longer than broad, broadening backwards, with median lateral constriction, lateral borders with two to three prominent setae. Frontal plates projecting. Second thoracic segment laterally projecting as a pair of small lobes over-reaching the lobes of the cephalothorax. Third segment roughly semicircular, partially fused with second segment. Fourth much narrower than third, produced into rounded lobes overlapping the base of the fourth legs and posteriorly bilobed. Genital segmet broader than free thoracic segments longer than broad, with short anterior neck, corners rounded. Abdomen attached to ventral side of genital segment, shorter than genital segment, indistinctly two-jointed and sparsely spiny. Caudal rami elongated and spiny, with five setae, apical seta long.

Basal segment of antennule with comparatively long setae, distal segment with one lower and a distal bunch of setae, five long and slender, four spine-like and two aesthete-like. Basal segment of antenna flat, without spine, second segment short, third stout and curved backwards at the distal third, base with two spine-like setae. Post-antennal process with triangular base and short blunt claw, associated with two rounded pad-like structures. Post-oral process elongate triangular. Maxillule with three small setae. Maxilla rather slender, apical claw about three times as long as subapical. Maxilliped slender, basal segment with small basal inner process. Sternal fork with long base and short diverging limbs.

Distal segment of exopod of first leg with three claws successively decreasing in length, all spiny, third with a prominent accessory process, spine-like seta plumose, shorter than third claw. Claws

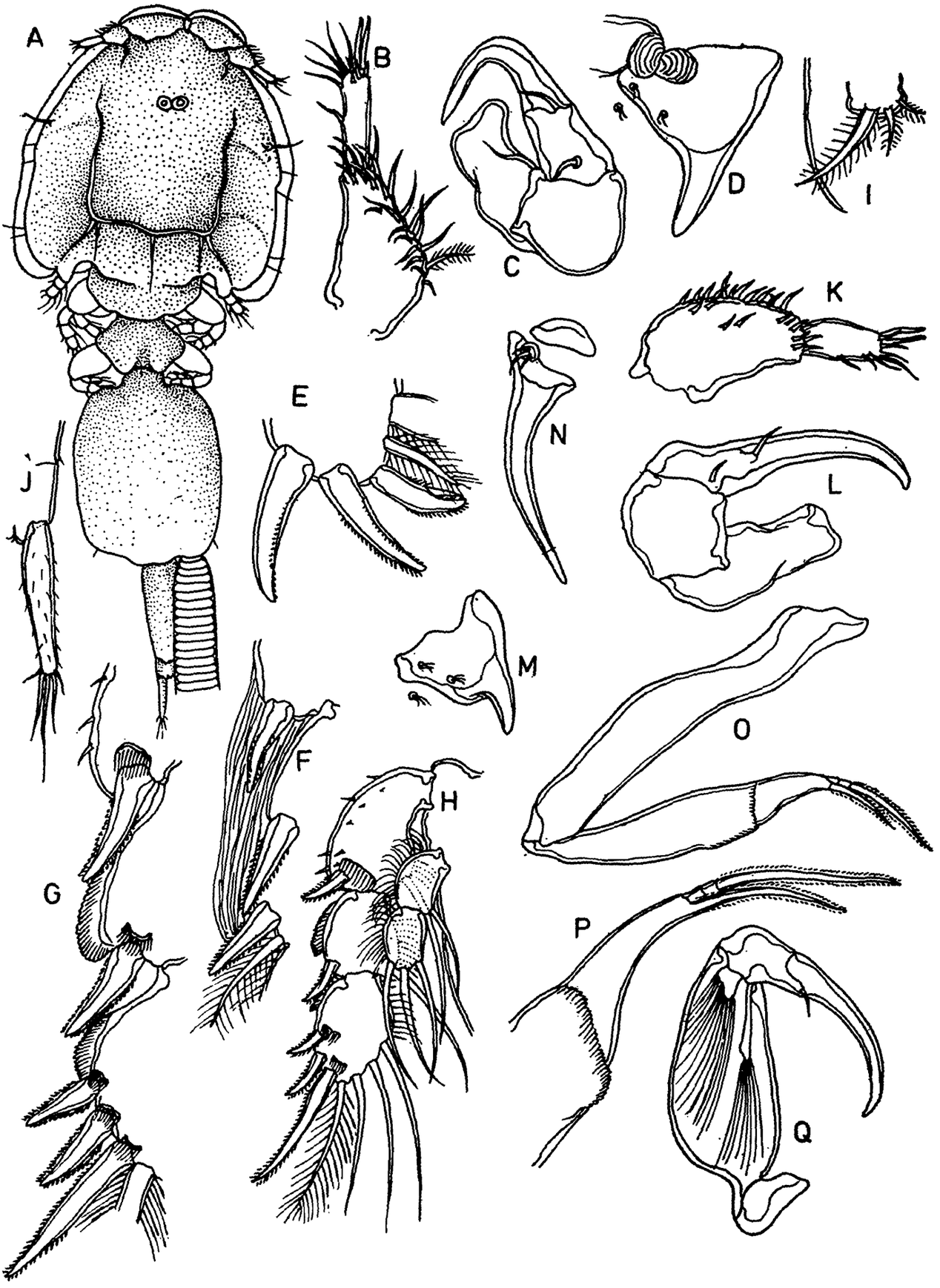


Fig. 67. A-J. *Trebius exilis* Wilson : A, female, dorsal view ; B, antennule ; C, antenna ; D, post-antennal process ; E, leg 1 ; F, leg 2, exopod ; G, leg 3, exopod ; H, leg 4 ; I, leg 5 ; J, caudal rumas. K-Q, *Trebius kirtii* Hameed and Pillai : K, antennule ; L, antenna ; M, post-antennal process ; N, post-oral process and maxillule ; O, maxilla ; P, same, tip enlarged ; Q, maxilliped.

on exopod of second leg subsimilar, spiny, first seta slender. Basal segment of exopod of third leg with three spines and a claw, second segment with frilled border and a claw, third segment with frilled border and three claws, third claw twice as long as second, each claw with a patch of spinules near base. Exopod of fourth leg more or less similar to that of third, last claw on third segment more than twice as long as the penultimate, endopod small.

*Length.*—5.2 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+(1)+III |
| Leg 2 | 1+0, 2+0, 6 | 1+I, 1+I, 6+I |
| Leg 3 | 1+0, 2+0, 4 | 1+I, 1+I, 5+III |
| Leg 4 | 1+0, 3 | 1+I, 1+I, 4+III |

*Host.—Rhinoptera javanica.*

*Distribution.*—Sri Lanka, India (Kerala).

**Trebius kirtii** Hameed and Pillai
(Fig. 67 K-Q, 68 A-F)

*Trebius kirtii* Hameed and Pillai, 1973a, p. 463, figs. 15-29.

*Female.*—Cephalothorax regularly widening backwards, postero-lateral lobes diverging. Second thoracic segment laterally not reaching the lobes of the cephalothorax. Third segment semicircular, not fully separated from second. Fourth segment rather short and narrow. Genital segment slightly broader than fourth segment, longitudinally oblong. Abdomen as long as the pregenital part of body, two-jointed, first segment half the length of second. Caudal rami flattened, oblong and sparasely spiny, with five comparatively small setae.

Antennule rather stout, with comparatively few short setae, distal segment rather broad. Basal segment of antenna flat, second stout, squarish, third long and only very slightly curved, with the usual two setae. Post-antennal process with irregularly triangular base and short slightly curved claw. Post-oral process long, narrow

and claw-like, very distinctive in appearance. Maxilla rather stout, distal segment medially broad, the membranous flange forming a transversely placed frill, distal claws short and subsimilar. Basal segment of maxilliped narrowing distalwards, distal segment slender and curved, as long as basal segment. Base of sternal fork long, limbs short and diverging, more or less like that of *T exilis*.

Claws on the distal segment of exopod of first leg stout and spiny, second longest, third with a small subapical accessory process, spine-like seta as long as the third claw, spiny instead of plumose. Second leg of the usual type, claws on exopod regularly decreasing in size. First claw of exopod of third leg equal to the last, second and third segments with an outer frill, basipod with a few spines. Basipod of fourth leg nearly circular, exopod similar to that of third leg in armature but different in setation, endopod two-jointed, comparatively large.

*Length*.—13.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+(1)+III |
| Leg 2 | 1+0, 2+0, 6 | 1+I, 1+I, 6+I |
| Leg 3 | 1+0, 2+0, 4 | 1+I, 1+I, 5+III |
| Leg 4 | 1+0, 3 | 1+I, 1+I, 4+III |

*Host*.—Unidentified ray.

*Distribution*.—India (Kerala).

*Remarks*.—The most characteristic feature of this species is its long abdomen making it resemble *T caudatus* Kroyer and *T longicaudatus* Shiino. However in these two species the genital segment is spiny while spines are absent in *T kirtii*. The antennule, antenna and the post-oral process of *T kirtii* have very characteristic shape which helps to identify this species.

### **Trebius javanicus** Hameed and Pillai
(Fig. 68 G-J, 69 A-I)

*Trebius javanicus* Hameed and Pillai, 1973a, p. 472, figs. 45-58.

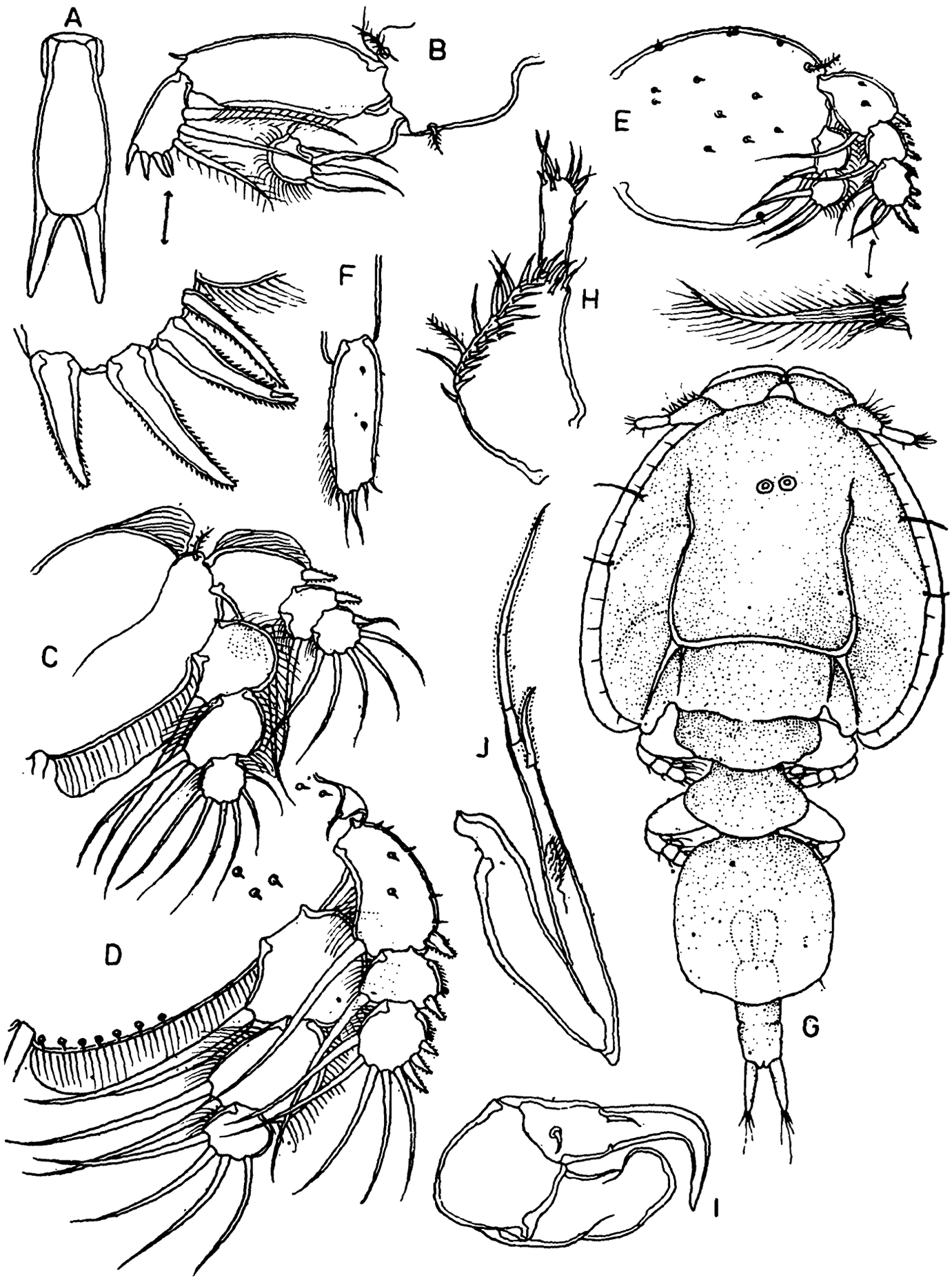


Fig. 68. A-F, *Trebius kirtii* (contd.) : A, sternal fork ; B-E, legs 1-4 ; F, caudal ramus. G-J, *Trebius javanicus* Hameed and Pillai : G, female, dorsal view ; H, antennule ; I, antenna ; J, maxilla.

*Female.*—Cephalothorax slightly longer than broad, with small medio-lateral declivity. Postero-lateral lobes curving slightly inwards. Frontal plates projecting. Lateral lobes of second segment projecting beyond those of cephalothorax. Third segment almost fully demarcated from second. Fourth segment comparatively large, transversely oblong, with large rounded lobes overlapping the base of the legs. Genital segment rather swollen, rounded, ventral side with scattered small spines. Abdomen apparently two-jointed and spiny, segmentation not distinct, attached to ventral side of genital segment. Caudal rami sparsely spiny, slightly narrowing, with slender apical setae, as long as the basal segment of the abdomen.

Basal segment of antennule with comparatively long slender setae. Third segment of antenna bent at right angles at the distal third. Post-antennal process with triangular base and slightly curved claw. Post-oral process elongate triangular and curved, maxillule with very short setae. Distal segment of muxilla much longer than basal, distal claw comparatively long. Basal segment of maxilliped rather stout, with proximal inner process, distal strongly curved. Base of sternal fork stout, limbs half the length of base, apically acute and clearly diverging.

First claw of distal exopod segment of first leg stout, third curving downwards, spine-like seta small and plumose. Claws on exopod of second leg subsimilar, sparsely spiny. Endopod of third leg comparatively much broader than exopod. Endopod of fourth leg fairly well developed.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+(1)+III |
| Leg 2 | 1+0, 2+0, 6 | 1+I, 1+I, 6+I |
| Leg 3 | 1+0, 2+0, 4 | 1:I, 1:I, 5+III |
| Leg 4 | 1+0, 3 | 1+I, 1+I, 4+III |

*Length.*—3.9 mm.

*Host.*—*Rhinoptera javanica.*

*Distribution.*—India (Kerala).

*Holotype.*—female in National Zoological Collection at Zoological Survey of India, Calcutta, Reg. No. C2114/2

*Remarks.*—The legs of *Trebius* spp. show rather monotonous uniformity and provide very little specific difference. On the other hand the cephalic appendages exihibit clear difference. For example every cephalothoracic appendage of *T kirtii* is peculiar. This is equally so in the case of *T sepheni.* The shape, segmentation and armature of the abdomen are also very helpful in specific identification.

**Trebius sepheni** Hameed and Pillai
(Fig. 69 J, 70)

*Trebius sepheni* Hameed and Pillai, 1973a, p. 469, figs. 30-44.

*Female.*—Cephalothorax broadening backwards, postero-lateral lobes fairly large and diverging. Frontal plates prominent and projecting. Second thoracic segment forming distinct lateral lobes just overreaching the lobes of the cephalothorax. Third thoracic segment irregular in outline, narrowed beyond the base of the legs. Fourth segment anteriorly narrowed. Genital segment roughly oval, suddenly narrowed at the distal one third, with anterior neck. Abdomen long, slender and sparsely spiny, three-jointed, first segment half the total length. Caudal rami not narrowing, longer than third abdominal segment.

Third segment of antenna distally recurved. Post-antennal process irregularly triangular, claw moderately stout, base with nearly circular excavation. Post-oral process elongate-triangular, inner basal part prolonged. Outer flange of distal segment of maxilla replaced by a patch of hairs, subapical claw short and characteristically curved, outer three times as long as inner. Basal segment of maxilliped long and rather slender, distal segment slender and short. Sternal fork with broad base, limbs converging and apically slightly diverging.

Distal segment of exopod of first leg with three subsimilar claws, all spiny, third with accessory process, spine-like seta plumose, as long as third claw, lower setae very stout. Basal segment of exopod

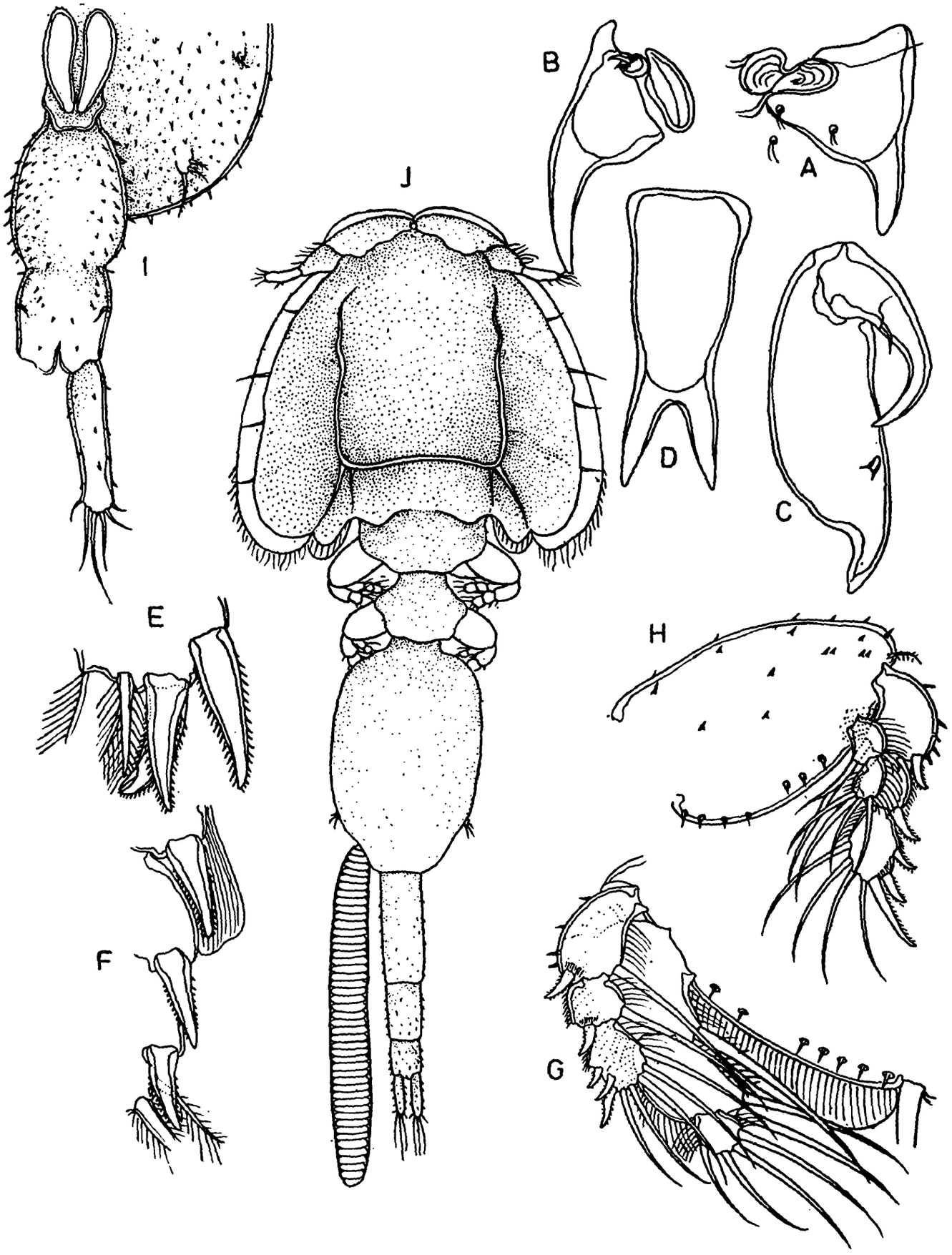


Fig. 69. A-I. *Trebius javanicus* (contd.) : A, post-antennal process ; B, post-oral process and maxillule ; C, maxilliped ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, leg 3 ; H, leg 4 ; I, genital segment, abdomen and caudal, ramus. J, *Trebius sepheni* Hameed and Pillai, female, dorsal view.

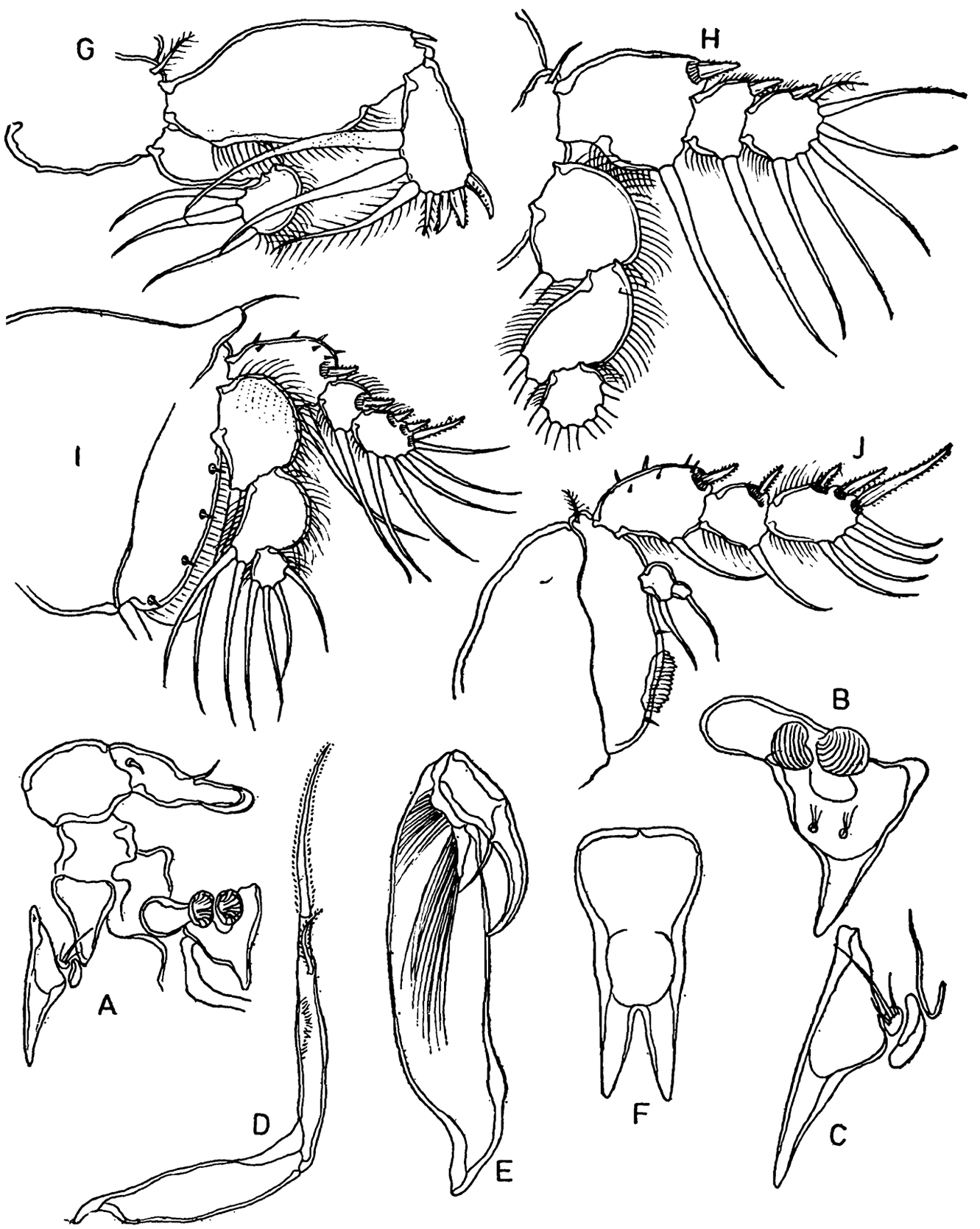


Fig. 70. *Trebius sepheni* (contd.) : A, antenna, post-antennal process, post-oral process and maxillule ; B, post-antennal process ; C, post-oral process and maxillule ; D, maxilla ; E, maxilliped ; F, sternal fork ; G-J, legs 1-4.

of second leg stout, claws of exopod rather small. Basipod of third leg with a conical process carrying the dorsal distal seta, spines on exopod slender, last two and a half times as long as the penultimate. Endopod of fourth leg very small, two-jointed, each segment with one seta, claws on exopod slender and spiny, last very long, setae comparatively short.

*Length.*—6.8 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 3 | 0+I, 3+(1)+III |
| Leg 2 | 1+0, 2+0, 6 | 1+I, 1+I, 6+I |
| Leg 3 | 1+0, 2+0, 4 | 1+I, 1+I, 5+III |
| Leg 4 | 1+0, 1 | 1+I, 1+I, 4+III |

*Host.—Pastinachus sephen.*

*Distribution.*—India (Kerala).

*Remarks.*—This species can be easily identified from the others described here by the shape of the genital segment and the maxilla and the maxilliped. The endopod of the fourth leg is most degenerated, each segment having only a single seta. The postero-lateral lobes of the cephalothorax appear to have a row of fine hairs as in *Pupulina*. If they are actually hairs and not some epizoic growths this would be an interesting character.

## Family CALIGIDAE

*Diagnosis.*—First three thoracic segments fused with cephalon forming a dorso-ventrally flattened cephalothorax. Fourth segment free, occasionally fused with genital segment and sometimes overlapped by cephalothorax. Genital segment swollen, variously modified and with or without wings and processes. Abdomen narrow, one-or more-segmented, with or without wings or lobes, occasionally fused with genital segment and absent. Caudal rami laminate and setose. Egg tubes long, eggs uniseriate.

Cephalothorax with a pair of frontal plates, with or without lunules. Basal segment of antennule flattened, with plumose setae,

distal segment with one lower and thirteen distal naked setae. Antenna prehensile, three-jointed. Post-antennal process present or absent. Post-oral process present, associated with maxillule composed of a tubercle carrying three setae. Maxilla two-jointed, distal joint with a thin outer flange and two distal claws. Maxilliped two-jointed and prehensile. Sternal fork present or absent.

First leg with vestigial endopod (except in *Pupulina*), distal exopod segment usually with three claws, a spine-like seta and three plumose setae, armature varying. Rami of second leg three-jointed, with varying armature. Basipods of third leg fused into a large apron, basal exopod segment modified into a claw (except in *Pupulina*), basal endopod segment generally fused with apron forming a velum. Fourth leg uniramous, one-to four-jointed, rarely reduced to a seta. Fifth and sixth legs vestigial.

Male smaller than female, its genital segment small, abdomen fully segmented. Antenna, post-antennal process, post-oral process and maxilliped generally with additional armature.

Type genus : **Caligus** Muller.

*Discussion.*—The most recent revision of the family by Yamaguti (1963) mainly based on published information needs some changes. In the present work subfamilies Echetinae and Mappatinae are discarded and family Eirgidae is sunk into subfamily Lepeophtherinae.

Within this family *Pupulina* is a misfit. As it cannot go into any other known family it is provisionally included here.

*Key to subfamilies of* CALIGIDAE

1. Lunules present ..... CALIGINAE
— Lunules absent ..... 2

2. Abdomen generally present, occasionally small or even absent ..... LEPEOPHTHERINAE
— Abdomen fused with genital segment ..... ANURETINAE

## Subfamily CALIGINAE

*Diagnosis.*—Frontal plates with lunules. Fourth thoracic segment free, occasionally fused with genital segment and the whole much elongated. Genital segment swollen, with or without processes or lobes. Abdomen distinct, may be flattened or lobed. Caudal rami lamellar.

Antenna prehensile. Post-antennal process present or absent. Post-oral process generally present. Maxilliped prehensile. Sternal fork present or absent. Legs as in the family.

Male with small genital segment. Abdomen fully segmented. Appendages as in the family.

*Discussion.*—The genera contained in this subfamily exhibit great uniformity in the structure of the cephalothorax and its appendages but considerable diversity in the post-cephalothoracic part of the body. But the generally conservative male shows the homogenity of the subfamily.

### *Key to genera of* CALIGINAE

1. Sternal fork present .2
— Sternal fork absent .8

2. Genital segment and abdomen normal .3
— Genital segment and abdomen enlarged, flattened, winged or with processes .4

3. Fourth leg normal *Caligus* Muller
— Fourth leg a stump with one to three setae .*Pseudocaligus* Scott

4. Fourth thoracic segment fused with genital segment and the whole elongated .5
— Fourth thoracic segment normal .*Synestius* Stp. & Lutk

5. Genital segment drawn out into a pair of elongated processes .6
— Genital segment not drawn out into processes .7

6. Lobes of genital segment dorsal to abdomen, latter narrow ..... *Caligodes* Heller
— Lobes of genital segment ventral to abdomen, latter broad ..... *Parechetus* Pillai

7. Genital segment and abdomen forming large wings ..... *Parapetalus* Stp. & Lutk
— Genital segment and abdomen not forming wings ..... *Pseudopetalus* Pillai

8. Abdomen subequal in length to cephalothorax and genital segment ..... *Abasia* Wilson
— Abdomen as long as genital segment and cephalothorax combined ..... *Sciaenophilus* van Beneden

## Genus **Caligus** Muller

*Caligus* Muller, 1785, p. 128 ; Wilson, 1905a, p. 555 ; Yamaguti, 1963 p. 47 ; Margolis et al, 1975, p. 7.

*Diagnosis.*—Frontal plates of cephalothorax with lunules. Fourth thoracic segment free, exposed, occasionally slightly overlapped by cephalothorax. Genital segment enlarged, may be subequal to cephalothorax in size. Abdomen usually narrow, one-or two-segmented, segmentation often indistinct, segments may be flattened or winged, Caudal rami with six plumose setae.

Basal segment of antennule flattened, with plumose or pectinate setae, distal segment with one lower and thirteen distal naked setae. Antenna three-segmented, basal segment with a process, distal with one or two slender spines. Post-antennal process very rarely absent, associated with three bunches of hairs or setae. Post-oral process only very rarely absent. Maxillule with one long and two short setae. Maxilla two-jointed, distal segment with a thin outer flange and two unequal claws, apical claw longer, with four rows of spinules, subapical short, with two rows. Maxilliped two-jointed and prehensile, distal segment with one or two spines. Sternal fork only very rarely absent.

First and fourth legs uniramous, second and third biramous, latter with the protopods fused into a broad lamina. Fourth leg two to four-segmented. Fifth and sixth legs vestigial, on the genital segment.

Male generally smaller than female. Genital segment small. Abdomen not modified, narrow and distinctly segmented. Second segment of antenna often with adhesion pads, third generally stumpy, bifid or trifid. Post-antennal process stronger sometimes strongly falcate. Basal segment of maxilliped generally with additional armature.

Parasites of teleosts, occasionally or elasmobranchs.

Type species : *C. curtus* Muller.

*Discussion.*—As all the genera of Caligidae closely resemble *Caligus* this genus is fully described. Recently Parker et al (1968) described the type species in considerable detail pointing out the defects that usually occur in the description of species of *Caligus.* The more common points are therefore summarised.

The distal segment of the antennule always has thirteen apical setae, all naked (there are exceptions regarding this). The lunules are ventral, never dorsal as usually illustrated. Antenna is three-segmented though the basal segment may be partially fused with the cephalothorax. The distal segment generally carries two spines, of which one is median and placed on an indistinct partition. The post-antennal process is always associated with three bunches of fine hairs, two on it and one outside. Even when the process is absent the setae are present. The hairs may be independant, fused basally or a long simple seta. The second segment of the maxilla always has an outer flange. The distal claw of the maxilliped has a spine placed on an indistinct partition.

Details of the armature of the distal segment of the first leg, shape of the claws on the exopod of the second leg, armature of its endopod, especially of the basal segment, armature of the apron of the third leg and the number of segments of the fourth leg often provide very useful diagnostic characters. In many descriptions of *Caligus* these details are absent. A careful study of the description of *C. curtus* by Parker et al will be rewarding.

*Key to species of* **Caligus**

| | | |
|---|---|---|
| 1. | Fourth leg two-jointed | *.planktonis* Pillai |
| — | Fourth leg three-jointed | .2 |
| — | Fourth leg four-jointed | .28 |

2. Abdomen one-jointed .3
— Abdomen two or more-jointed .16

3. Genital segment as long as cephalothorax *.amblygenitalis* Pillai
— Genital segment shorter than cephalothorax .4

4. Abdomen nearly as long as broad .5
— Abdomen longer than broad .9

5. Sternal fork asymmetrical *.asymmetricus* Kabata
— Sternal fork symmetrical .6

6. Legs five and six with chitinised procasses *.tylosuri* (Rangnekar)
— Legs five and six without chitinised processes 7

7. Lunules very small, placed at the outer end of the frontal plates *furcisetifer* Redkar *et al.*
— Lunules normal .8

8. Apical claw of leg four normal *.Polycanthi* Gnanamuthu
— Apical claw of leg four long and slender *.longipedis* Bassert-Smith
— Apical claw of leg four very long and stout *.russellii* Kurian

9. Sternal fork absent *.uruguayensis* Thomsen
— Sternal fork present .10

10. Surface of leg four with small denticles *.dasyaticus* Rangnekar
— Surface of leg four smooth .11

11. Apical claw of maxilla dentate *.priacanthi* Pillai
— Apical claw of maxilla not dentate 12

12. Endopod of leg two with hairy outer border *.chrysophrysi* sp. nov.
— Endopod of leg two with spiny or dentate outer border 13

13. Lower border of distal segment of leg one with setae 14
— Lower border of distal segment of leg one without setae 15

| | | |
|---|---|---|
| 14. | Post-antennal process a simple plate | *.phipsoni* Bassett-Smith |
| — | Post-antennal process claw-like | *.holocentri* sp. nov. |
| 15. | Basal process of antenna long | *.annularis* Yamaguti |
| — | Basal process of antenna normal | *.chiloscyllii* (Pillai) |
| 16. | Outer border of endopod of leg two dentate | .17 |
| — | Outer border of endopod of leg two spiny | .20 |
| — | Outer border of endopod of leg two hairy | .24 |
| 17. | Genital segment subequal to cephalothorax in width, first segment of abdomen enlarged | *.malabaricus* Pillai |
| — | Genital segment narrower than cephalothorax, first segment of abdomen not enlarged | 18 |
| 18. | Genital segment postero-laterally produced into rounded lobes | *.productus* Dana |
| — | Genital segment postero-laterally not produced into rounded lobes | 19 |
| 19. | Spine-like seta on leg one naked, second segment of leg four dentate | *.auxisi* Pillai |
| — | Spine-like seta on leg one hairy, second segment of leg four not dentate | *.borito* Wilson |
| 20. | Lower border of distal segment of leg one without setae | *.epinepheli* Yamaguti |
| — | Lower border of distal segment of leg one with setae | .21 |
| 21. | Lateral parts of cephalothorax folded downwards | *.lagocephali* Pillai |
| — | Lateral parts of cephalothorax not folded downwards | .22 |
| 22. | Ganital segment postero-laterally produced into lobes | *.infestans* Heller |
| — | Genital segment postero-laterally not produced into lobes | .23 |
| 23. | Spine-like seta on distal segment of leg one naked | *.indicus* Pillai |
| — | Spine-like seta on distal segment of leg one hairy | *.quadratus* Shiino |

24. Limbs of sternal fork short, flattened — *.pelagicus* Kurian
— Limbs of sternal fork not short, not flattened — .25

25. Post-antennal process reduced to a simple plate — *unguidentatus* Redkar *et al*
— Post-antennal process claw-like — .26

26. Claws on distal segment of leg one apically cut into lobes — *.hamruri* Pillai
— Claws on distal segment of leg one not apically cut into lobes — .27

27. Spine-like seta on distal segment of leg one long and spiny — *.undulatus* Shen & Li
— Spine-like seta on distal segment of leg one long and naked — *.savala* Gnanamuthu

28. Abdomen one-segmented — .29
— Abdomen two-segmented — .33

29. Distal segment of leg four with two claws — .30
— Distal segment of leg four with three claws — .31

30. Abdomen asymmetrical — *.distortus* Pillai & Natarajan
— Abdomen symmetrical — *nengai* Rangnekar, Rangnekar & Murti

31. Genital segment as broad as cephalothorax — *.bicycletus* Heegaard
— Genital segment broader than cephalothorax — *parapetalopsis* Hameed & Pillai
— Genital segment narrower than cephalothorax — .32

32. Post-antennal process with accessory lobe — *.confusus* Pillai
— Post-antennal process without accessory lobe — *.platurus* Kirtisinghe

33. Claws on leg one with ventral frill — *.arii* Bassett-Smith
— Claws on leg one without ventral frill — .34

34. Abdomen asymmetrical — *.clavatus* Kirtisinghe
— Abdomen symmetrical — .35

35. Genital segment with postero-lateral lobes — .36
— Genital segment without postero-lateral lobes — .37

36. Abdomen four-to six-jointed — *.coryphaenae* Stp. & Lutk
— Abdomen two-jointed — *.euthynnus* Kurian

37. Post-oral process with a partition, first claw of exopod of leg two very small, far away from second — *.robustus* Bassett-Smith
— Post-oral process without partition, first claw on exopod of leg two not very small, close to second — .38

38. First segment of abdomen enlarged and swollen — .39
— First segment of abdomen not enlarged or swollen — .41

39. Claws on leg four pectinate — *.rotundigenitalis* Yu
— Claws on leg four not pectinate — .40

40. Spine-like seta on distal segment of leg one similar to the claws — *.laticaudus* Shiino
— Spine-like seta on distal segment of leg one different from the claws — *.constrictus* Heller

41. Abdomen longer than genital segment — .42
— Abdomen shorter than genital segment — .46

42. Genital segment subequal to cephalothorax in size — .43
— Genital segment smaller than cephalothorax — .44

43. Leg four modified — *.kanagurta* Pillai
— Leg four not modified — *.cybii* Bassett-Smith

44. Some of the setae on distal segment of antennule very long, claws on leg four normal — *.longicaudus* Bassett-Smith
— All setae on distal segment of antennule short, claws on leg four pectinate — .45

45. Limbs of sternal fork flat and circular .. — *.platytarsis* Bassett-Smith
— Limbs of sternal fork not flat, not circular — *.multispinosus* Shen

46. Basal process of antenna rounded — .47
— Basal process of antenna not rounded — .48

47. Abdomen flattened *.cordyla* Pillai
— Abdomen not flattened *.tenax* Heller

48. Claws on leg one apically blunt and lobed .49
— Claws on leg one apically pointed *.brevicaudus* Pillai

49. Second segment of abdomen postero-laterally produced into large spiny lobes *.lobodes* (Wilson)
— Second segment of abdomen postero-laterally produced into small smooth lobes *.cornutus* Heegaard

## **Caligus amblygenitalis** Pillai

(Fig. 71)

*Caligus amblygenitalis* Pillai, 1961, p. 98, fig. 7 ; 1967d, p. 1580, fig. 43 ; Silas and Ummerkutty, 1967, p. 957, fig. 40 ; Margolis *et al.*, 1975, p. 13.

*Female.*—Cephalothorax rather elongated, frontal plates slightly slanting, antero-median part angular. Membranous flange of frontal plates narrow, lunules as deep as frontal plates. Postero-median lobe of cephalothorax very broad, about four times as broad as lateral lobes, posterior sinuses fully open. Fourth thoracic segment small, partially fused with genital segment. Genital segment large, oblong, with large apically rounded postero-lateral lobes. Abdomen one-segmented, with small proximal constriction, more than twice as long as broad. Caudal rami twice as long as broad, sunk into the abdomen.

Antenna short and stumpy, basal process short. Post-antennal process long, stout, with enlarged base, claw distally flanged, setac associated with it long. Post-oral process elongate triangular, distally flanged, with an accessory process external to it. Maxillule with one long and two short setae. Maxilla and maxilliped normal. Sternal fork with short distally constricted base and stout distally flattened diverging limbs.

Distal segment of first leg with short but strong claws, first straight, second and third curved, ventrally serrated, with sharp accessory process, spine-like seta large, naked, ventral setae large and basally spiny. First claw of exopod of second leg stout, with

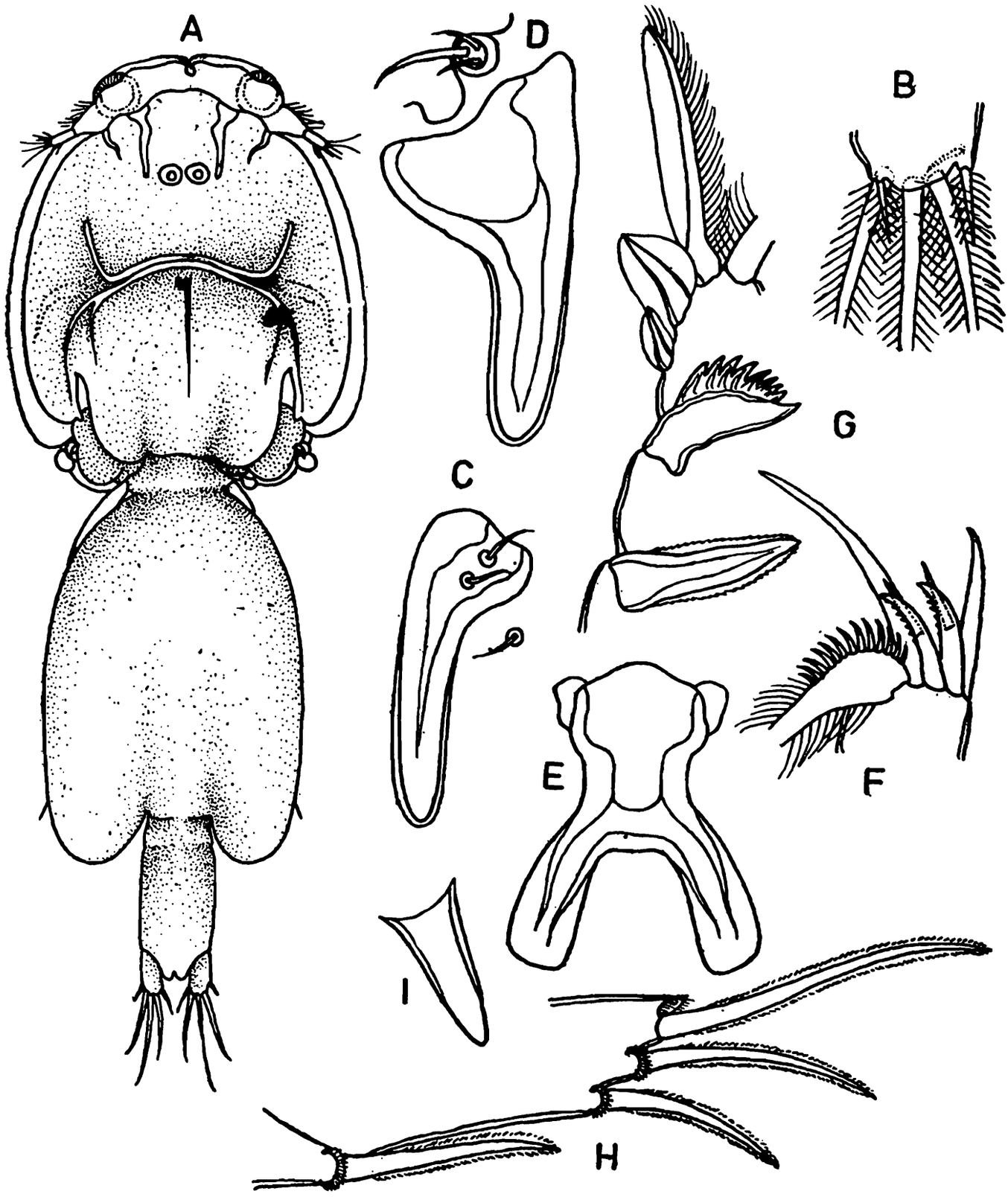


Fig. 71. *Caligus amblygenitalis* Pillai : A. female,dorsal view ; B, tip of caudal ramus ; C, post-antennal process ; D, post-oral process and maxillule ; E. sternal fork ; F, leg 1 : G, leg 2, exopod ; H. leg 4 ; 1, accessory process behind post oral process.

narrow serrate flange, second claw with a high outer crest cut into eight strong teeth, third claw like the first modified seta, with broad wings. Endopod segments externally with stiff setules. Basal claw of exopad of third leg parallel-sided, slightly incurved. Fourth leg three-segmented, with weak winged claws.

*Length.*—3.2 mm.

*Host.—Euthynnus affinis.*

*Distribution.*—India (Kerala).

*Holotype*—Female in the National Zoological Collection at Z.S.I., Calcutta, Reg. No. C2115/2.

*Remarks.*—This species resembles *C. glandifer* Shiino (1954) and *C. klawei* Shiino (1959) in the enlargement of the genital segment but can be easily distinguished by the shape of the abdomen, post-antennal process, sternal fork and above all by the second claw of the exopod of the second leg.

## **Caligus annularis** Yamaguti

(Fig. 72)

*Caligus annularis* Yamaguti, 1954, p. 385, pl. 4, figs. 33-34 ; 1963, p. 49, pl. 59, fig. 5 ; Pillai, 1966, p. 126, fig. 3 ; 1967d, p. 1581, fig. 47 ; Margolis *et al.* 1975, p. 13.

*Female.*—Cephalothorax as long as broad, frontal plates deep and projecting, with large circular lunules. Postero-median lobe nearly four times as broad as lateral lobes and clearly overreaching them. Fourth segment broader than long. Genital segment triangular, with short anterior neck. Abdomen one-segmented, narrowing.

Basal segment of antennule broad and triangular. Antenna strong, basal prologation unusually long. Post-antennal process large, bent in the middle. Post-oral process elongate triangular. One of the setae of maxillule very long. Maxilla and maxilliped normal. Sternal fork with narrow diverging apically incurved limbs.

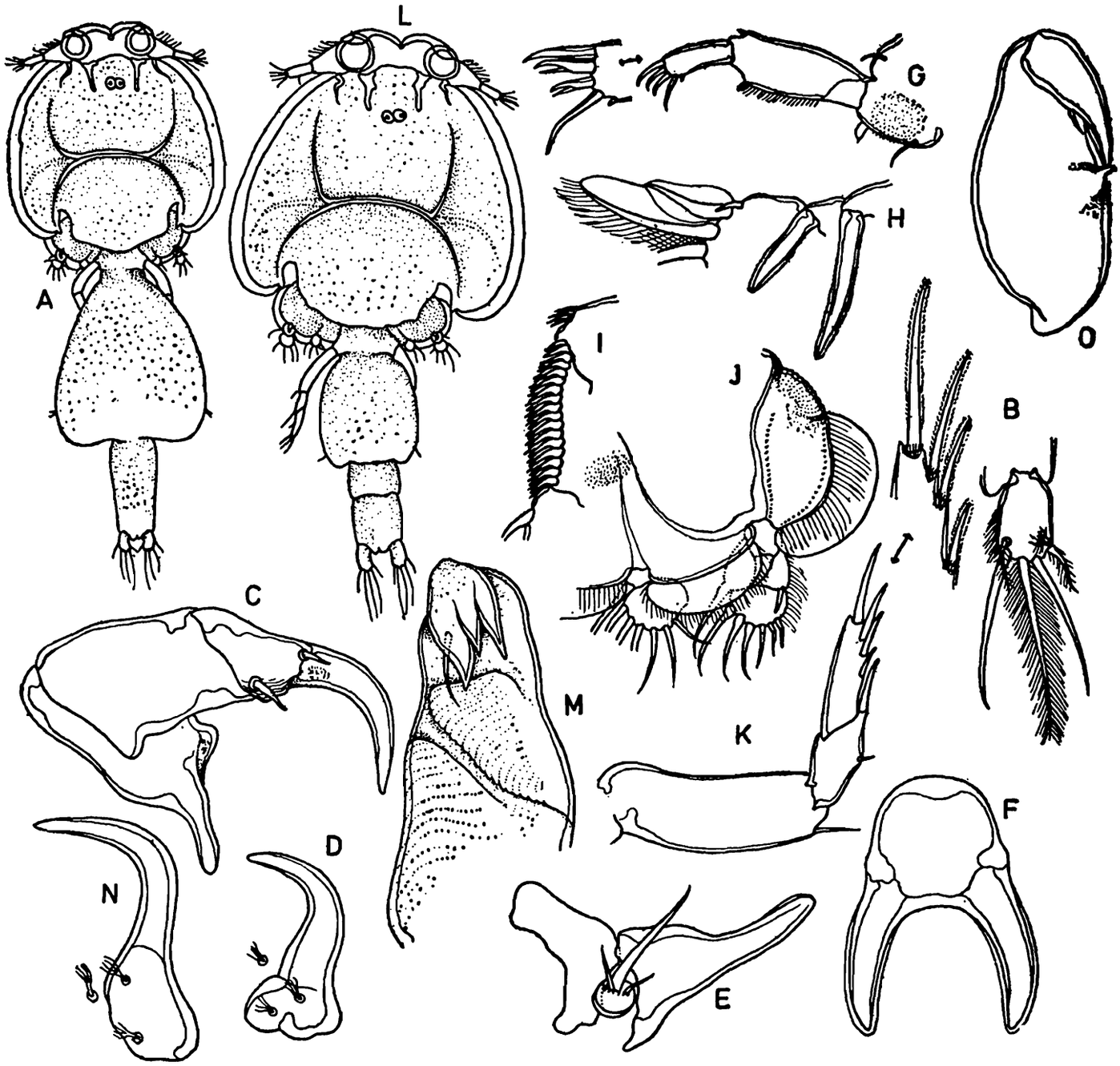


Fig. 72. *Caligus annularis* Yamaguti ; A-K, Female. A, female, dorsal view ; B, caudal ramus ; C, antenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, sternal fork ; G, leg 1 : H. leg 2, exopod ; 1, same, endopod ; J. leg 3 ; K, leg 4. L-O, Male ; L, male, dorsal view ; M, antenna ; N, post-antennal process ; O, maxilliped.

Basipod of first leg with a patch of denticles, distal segment with three short claws, second and third with accessory process, spine-like seta longer than the claws, naked, ventral border with a minute spine, no setae. First two claws on exopod of second leg long,

with narrow serrate flange, third very small, first two setae with broad wings, first endopod segment with four sharp spines, second with two to three rows of bent spines. Apron of third leg spiny, basal claw of exopod small, slightly curved. Fourth leg three-segmented, basal segment longer than rest of limb.

*Length.*—2.3 mm.

*Male.*—Cephalothorax broadening backwards, lunules large, as deep as frontal plates, postero-median lobe more rounded. Genital segment small, longer than broad, as long as abdomen, latter distinctly two-jointed, second segment longer than first. Second segment of antenna with two large adhesion pads, third segment short and trifid. Post-antennal process stronger than in female. Basal segment of maxilliped with median inner sharp process.

*Host.—Hapalogenys mucronatus, Otolithus maculatus.*

*Distribution.*—Japan, Celebes and India (Kerala).

## **Caligus arii** Bassett-Smith
(Fig. 73)

*Caligus aril* Bassett-Smith, 1898b, p. 82, pl. 4, fig. 1 ; Wilson, 1905a, p. 560 ; Yamaguti, 1963, p. 49 ; Pillai 1963f, p. 71 fig. 3 ; 1967d, p. 1575, fig. 31 ; 1969, p. 154, figs. 24-34 ; 1970a, p. 267 ; Kirtisinghe, 1964, p. 58 ; Margolis *et al.*, 1975, p. 14.

*Female.*—Cephalothorax nearly circular, frontal plates deep but not much projecting, lunules small and inconspicuous. Postero-median lobe nearly as broad as lateral lobes, over-reaching them. Posterior sinuses nearly closed. Fourth segment small. Genital segment broadening backwards, its hind border transverse. Abdomen as long as genital segment, two-jointed, distal segment very short, Caudal rami minute, sunk into the abdomen, with long setae.

Basal segment of antennule with prominent pectinate setae. Basal process of antenna very small, third segment very long. Post-anternal process absent. Post-oral process large, elongated and apically blunt. One of the setae of maxillule very long. Apical claw of maxilla very long, outer flange prominent. Maxilliped very

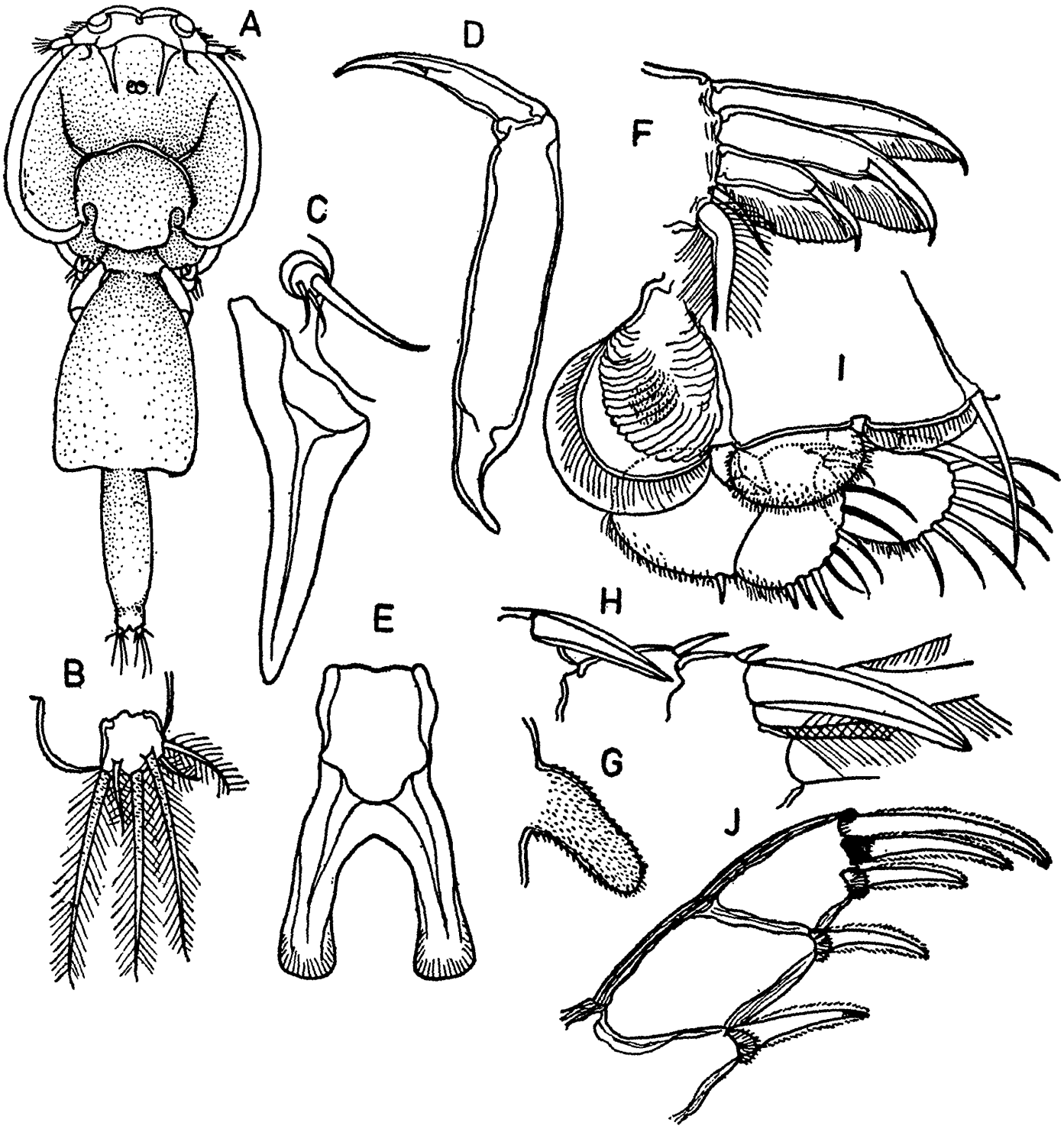


Fig. 73. *Caligus arii* Bassett-Smith : A, female, dorsal view ; B, caudal remus ; C, post-oral process and maxillule ; D, maxilliped ; E, sternal fork ; F, leg 1 ; G, same vestigial endoped ; H, leg 2, exopod ; 1, leg 3 ; J, leg 4.

slender, distal segment comparatively short. Limbs of sternal fork as long as base, slighly diverging and apically expanded.

Dorsal seta on basipod of first leg unusually large, vestigial endopod large, oblong and curved, with stiff spinules, distal segment

of exopod with large claws having prominent ventral frill, second and third with long accessory process, spine-like seta short, naked, ventral setae large. First claw on exopod of second leg large, winged, second and third small, first seta stout and winged, second dorsally winged, endopod segments with patches of stiff spinules. Apron of third leg reduced in size, outer part bulging, with prominent adhesion pad, rami highly flattened and overlapping, basal claw of exopod very small, borders of rami and velum heavily pectinate. Fourth leg four-segmented, somewhat flattened, claws strong and winged.

*Length.*—6.0 mm.

*Host.*—*Arius acutirostris*, *A. dussumieri*, *Pseudarius jatius.*

*Distribution.*—Sri Lanka, India (Kerala).

*Remarks.*—The specimens recorded from South Africa by Barnard (1955) differ in the absence of the second abdominal segment. The fourth leg is three-segmented. Kirtisinghe (1964) considered these specimens as belonging to *C. dakari* van Beneden. This view appears to be correct but Kirtisinghe did not provide details about his specimens. I, therefore, am unable to express any opinion.

### **Caligus asymmetricus** Kabata
(Fig. 74)

*Caligus asymmetricus* Kabata, 1965b, p. 109, figs. 1B-C ; Lewis, 1967, p. 131, figs. 49-51 ; 1968, p. 51 ; Pillai, 1967d, p. 1574, fig. 30 ; Margolis *et al.*, 1975, p. 15.
*Caligus thynni* Pillai, 1963f, p. 89, fig. 14.

*Female.*—Cephalothorax comparatively very large frontal plate-prominent and projecting, with large circular lunules, Posteros median lobe of cephalothorax about three times as broad as lateral lobes and projecting far beyond the latter, postero-medially produced to meet the fourth segment. Latter prominent. Genital segment roughly triangular, postero-laterally angular, posterior border nearly transverse. Abdomen very short, one-segmented and squarish, with faint proximal constriction. Caudal rami sunk into the abdomen.

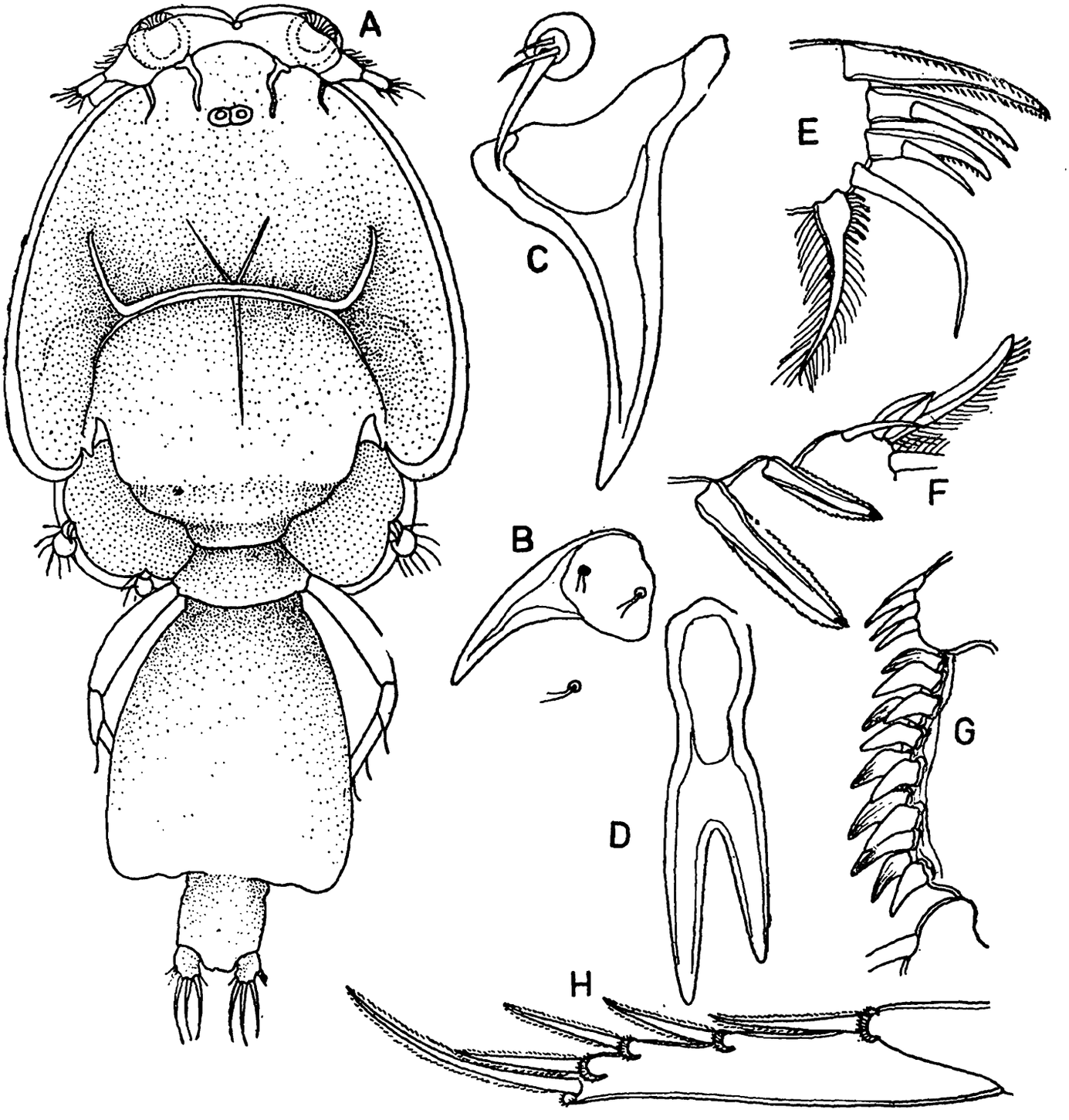


Fig. 74. *Caligus asymmetricus* Kabata : A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 : F, leg 2 ; exopod ; G, same, endopod ; H, leg 4.

Antennule and antenna of the usual type. Post-antennal process with stout base and progressively narrowing claw, selae associated with it long and bifid. Post-oral process large, with broad base, claw curved and acute. Maxilla and maxilliped normal. Sternal fork

slender, base medially constricted, limbs prominently asymmetrical, narrowing and slightly diverging.

Claws on distal segment of first leg stout, first claw with serrate flange, second and their with unusually large accessory process, spine-like sela twice as long as the third claw, curved and naked, ventral setae basally swollen and spiny. First two claws on exopod of second leg large, with prominent serrate wrings, third claw long, slender and spine-like. First segment of endopod with four spines, second with twelve stout curved teeth in two irregular rows. Rami of third leg placed wide apart. Fourth leg three-segmented, distal claw of third segment more than twice as long as the penultimate

*Length.*—3.5 mm.

*Host.*—*Euthynnus affinis. E. yaito, E. alleteratus, Grammatorcycnus bilineatus, Sarda orientalis.*

*Distribution.*—India (Kerala), Hawaii, Queensland, Marshall Islands.

*Holotype*—Female in National Zoological Collection at Z.S.I., Calcutta, Reg. No. C2116/2.

*Remarks.*—Since its original discovery from Kerala waters this species was collected at Queensland and Hawaii. The first two records included a single female but Lewis collected a female and three males. The male differs from the female in its distinctly two-jointed abdomen and the modified antenna and post-antennal process. Second segment of the antenna has an inner distal adhesion pad and a short third segment. The post-antennal process is a stout claw.

## **Caligus auxisi** Pillai
(Fig. 75)

*Caligus auxisi* Pillai, 1963f, p. 85, fig. 12 ; 1967d, p. 1578, p. 37 ; Silas and Ummerkutty, 1967, p. 957, fig. 38 ; Margolis *et al.*, 1975, p. 15.

*Female.*—Cephalothorax roughly semicircular frontal plates deep and projecting, lunules large and prominent. Postero-median

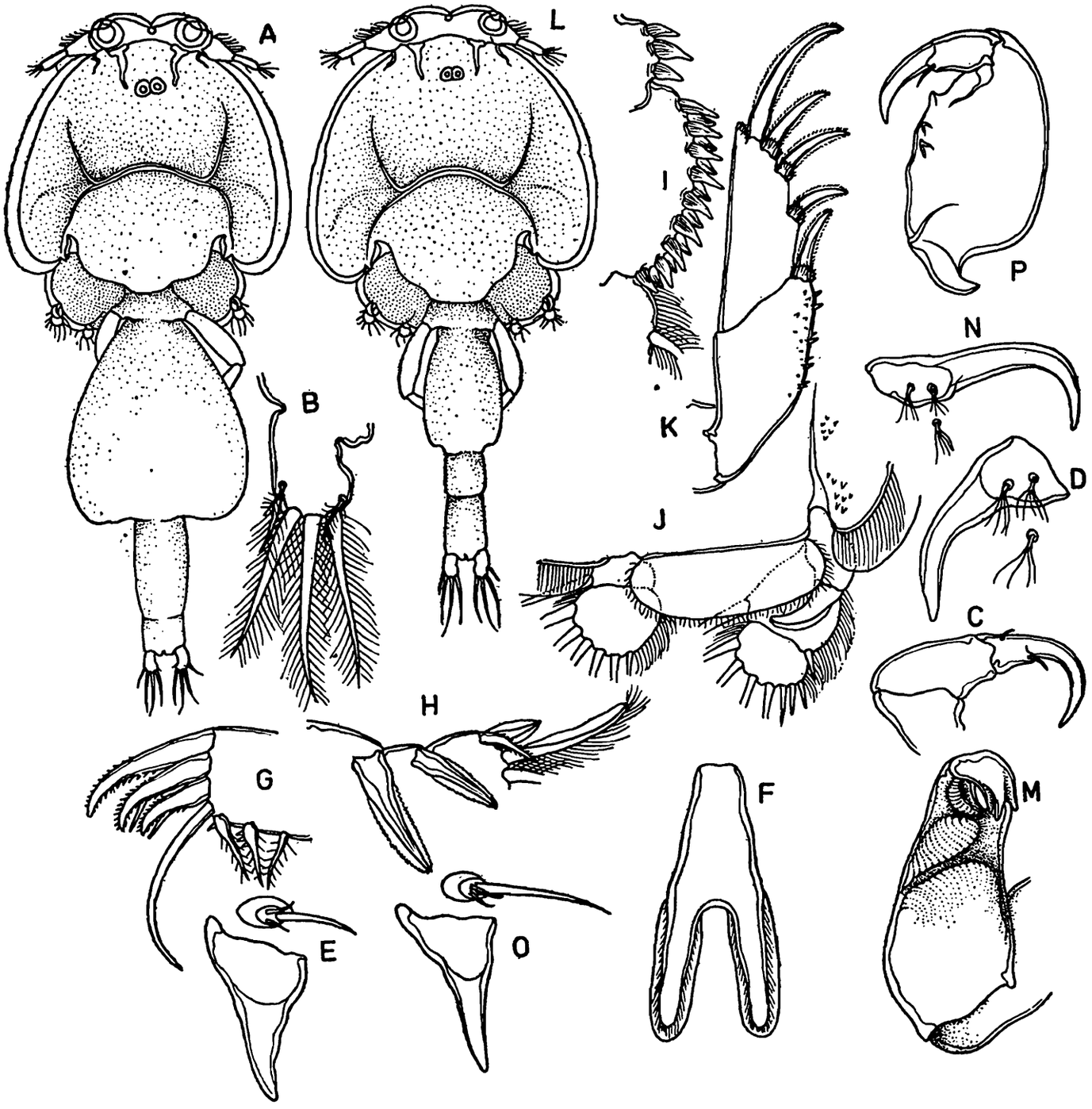


Fig. 75. *Caligus auxisi* Pillai : A-K, Female. A, female, dorsal view ; B, caudal ramus ; C, antenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, same, endopod ; J, leg 3 ; K, leg 4, L-P, Male. L, male, dorsal view ; M, antenna ; N, post-antennal process ; O, post-oral process and maxillule ; P, maxilliped.

lobe of cephalothorax about twice as broad as lateral lobes, posterior sinuses fully open. Genital segment flask-shaped, more than two-thirds as long as cephalothorax. Abdomen two-segmented, first

segment about three times as long as second, segmentation indistinct. Caudal rami longer than broad, with stout setae.

Basal segment of antenna indistinct, distal segment slender and strongly curved. Post-antennal process a strong-curved claw. Post-oral process elongate-triangular. One of the setae of maxillule long. Basal segment of maxilliped stout. Base of sternal fork narrow, limbs stout and diverging, with prominent wings all around.

First leg short but strong, distal exopod segment with three small ventral setae basally armed with teeth and distally with stiff spinules, spine-like seta long, smooth and curved, claws moderately curved, spiny on both sides, second and third claws with accessory process. First two claws on exopod of second leg winged, third long and barbed, basal segment of endopod with three and second with about seventeen teeth in two rows, teeth roughly alternating. Basal claw of exopod of third leg strongly curved and externally flanged, rami placed wide apart. Fourth leg three-segmented and stout, distal part of ventral border of first and second segments with scattered spines, claws with serrate wings, successively increasing in length.

*Length.*—3.8 mm.

*Male.*—Cephalothorax as in female, frontal plates deeper and lunules more prominent. Postero-median lobe of cephalothorax narrower and more projecting. Genital segment about twice as long as broad. Abdomen two-segmented, first segment half as long as second. Second segment of antenna with three adhesion pads, third segment short but stout, trified. Post-antennal process a narrow, long, strongly curved claw. Basal segment of maxilliped swollen, with three low tooth-like processes, distal segment strongly curved.

*Length.*—2.7 mm.

*Host.—Auxis thazard.*

*Distribution.*—India (Kerala).

*Holotype* Female and *Allotype* male in the National Zoological Collection at Z.S.I., Calcutta, Reg. No. C2117/2 & C2118/2.

*Remarks.*—This species closely resembles *C. indicus* Pillai (1961) and *C. bonito* Wilson (1905a) but differs in the shape of the abdomen and the sternal fork.

## **Caligus bicycletus** Heegaard
(Fig. 76)

*Caligus bicycletus* Heegaard, 1945a, p. 1, figs. 1-5 ; Yamaguti, 1963, p. 50 ; Margolis *et al.*, 1975, p. 18.

*Caligus djedabae* Rangnekar, 1956, p. 42, figs. ; Pillai, 1961, p. 96, fig. 5 ; 1967d, p. 1585, fig. 56 ; Ya aguti, 1963, p. 52, pl. 64, fig. 4 ; Margolis *et al.*, 1975, p. 31.

*Female.*—Cephalothorax nearly circular, frontal plates low, lunules projecting. Postero-median lobe about one and a half times as broad as lateral lobes and only slightly projecting beyond them, latter curving inwards. Fourth thoracic segment much broader than long, partially fused with genital segment, latter very large, subequal to cephalothorax in size, antero-laterally evenly curved, postero-laterally angular. Abdomen very short, nearly equal in length and width, with slight median constriction. Caudal rami small.

Distal segment of antennule long. Basal segment of antenna with prominent process, distal segment long and slender, apically recurved. Post-antennal process robust, apically blunt, base with a lower conical subsidiary process and upper rounded prominence. Post-oral process nearly as broad as long, with small subsidiary process. One of the setae of maxillule stout. Maxilliped robust, distal segment prominently curved, distal half of its lower border corrugated. Sternal fork with diverging apically rounded limbs.

Protopod of first leg spiny, distal exopod segment with two very small setae on lower border, spine-like seta naked, longer than the claws, claws ventrally spiny, second and third with accessory process. Claws on exopod of second leg small, with serrate wings, basal segment of endopod with a serrate crest, other segments hairy. Apron of third leg with scattered large spines and apically forked chitinised rib, rami placed close to each other, basal claw of exopod well curved. Fourth leg four-jointed, basal segment as long as rest of limb, rather broad, claws short and subsimilar.

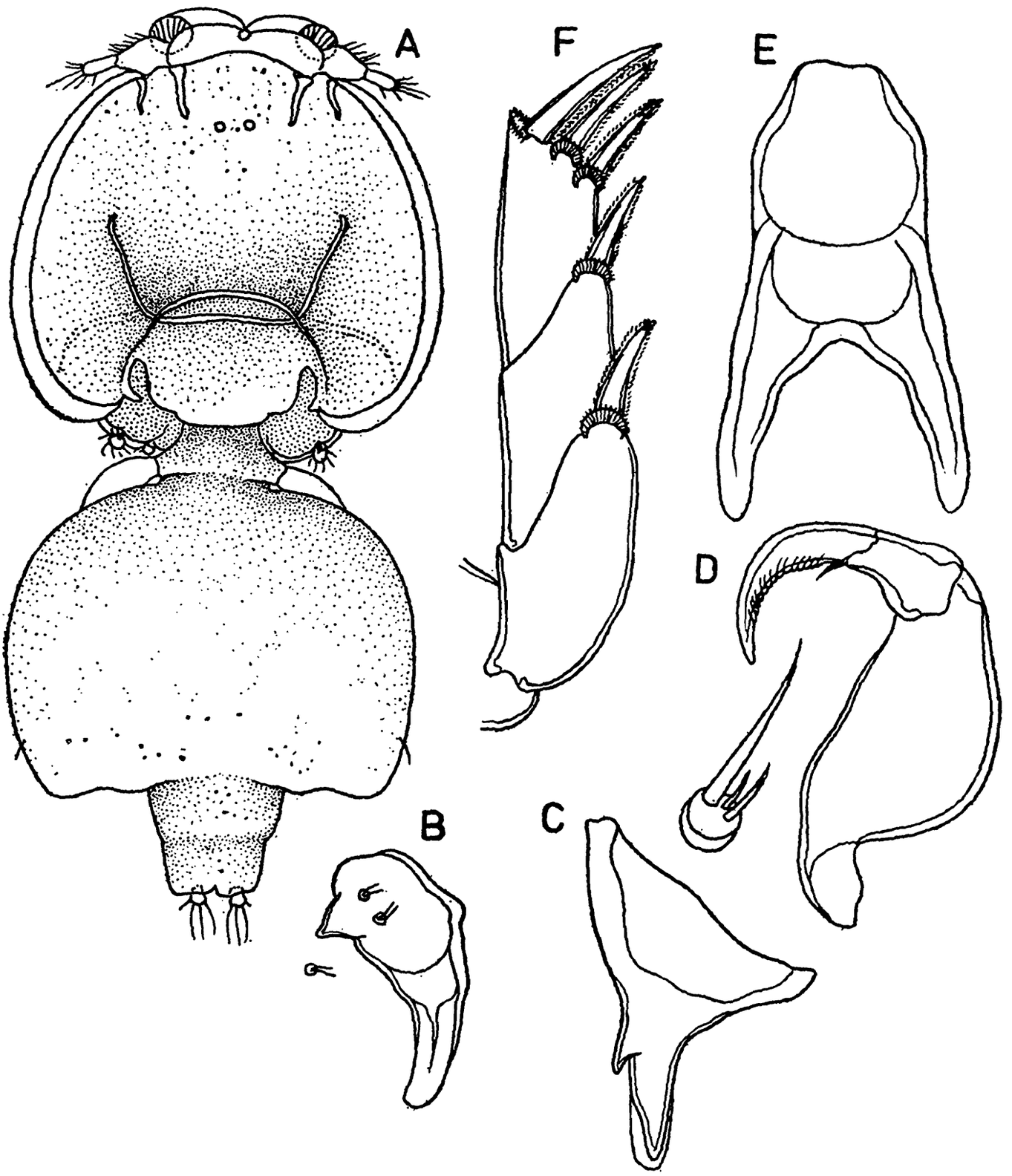


Fig. 76. *Caligus bicycletus* Heegaard : A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, maxilliped ; E, sternal fork ; F, leg 4.

*Length.*—1.9 mm.

*Host.—Atule djedaba, Selar kalla.*

*Distribution.*—Java, India (Bombay, Kerala).

*Remarks.*—The original description of this species by Heegaard lacks details especially regarding the appendages. His illustrations hardly depict the features. But the description is accurate and so clearly applies to the present specimen that there is no doubt that *C. djedabae* is the same as *C. bicycletus.*

In her original description of *C. djedabae* Rangnekar compared it with *C. tenax* Heller, *C. robustus* Bassett-Smith and *C. tenago* Yamaguti with which *C. djedabae* shows practically no similarity. It is likely that Rangnekar did not know of Heegaard's publication. This small *Caligus* has a very characteristic appearance.

## **Caligus bonito** Wilson
(Fig. 77)

*Caligus bonito* Wilson, 1905a, p. 479, pl. 13, figs. 150-153 ; 1932, p 398, fig. 255 ; Yamaguti, 1936b, p. 8, pls. 5-6, figs 72-85 ; Carvalho, 1951, p. 136 ; Markevich, 1956, p. 6, fig 64 ; Nunes-Ruivo, 1956, p 10, pl. 2 ; Yamaguti, 1963, p 50, pl. 56, fig. 3 ; Kabata, 1965b, p. 120 ; Lewis, 1967, p 124, figs. 46-48 ; Silas and Ummerkutty, 1967, p 877, fig. 1 ; Pillai, 1969, p. 161, figs. 63-80 ; Margolis *et al*, 1975, p. 18.

*Caligus kuroshio* Shiino, 1959b, p. 51, figs. 1-2 ; Pillai, 1963f, p. 80, fig. 9 ; Yamaguti, 1963, p. 55, pl 71, fig. 3 ; Margolis *et al.*, 1975, p. 41.

*Caligus krishnai* Thomas, 1967, p 137.

*Female.*—Cephalothorax as long as broad. Frontal plates prominent and projecting, lunules as deep as frontal plates. Posteromedian lobe moderately projecting beyond lateral lobes, slightly more than twice as broad as the latter, posterior sinuses wide open. Fourth thoracic segment much broader than long. Genital segment swollen, remotely triangular, with short anterior neck, posterolaterally rounded. Abdomen long and slender, two-jointed, basal segment twice as long as distal. Caudal rami longer than broad.

Basal segment of antenna with small process. Post-antennal process hook-like, distally curved. Post-oral process elongate,

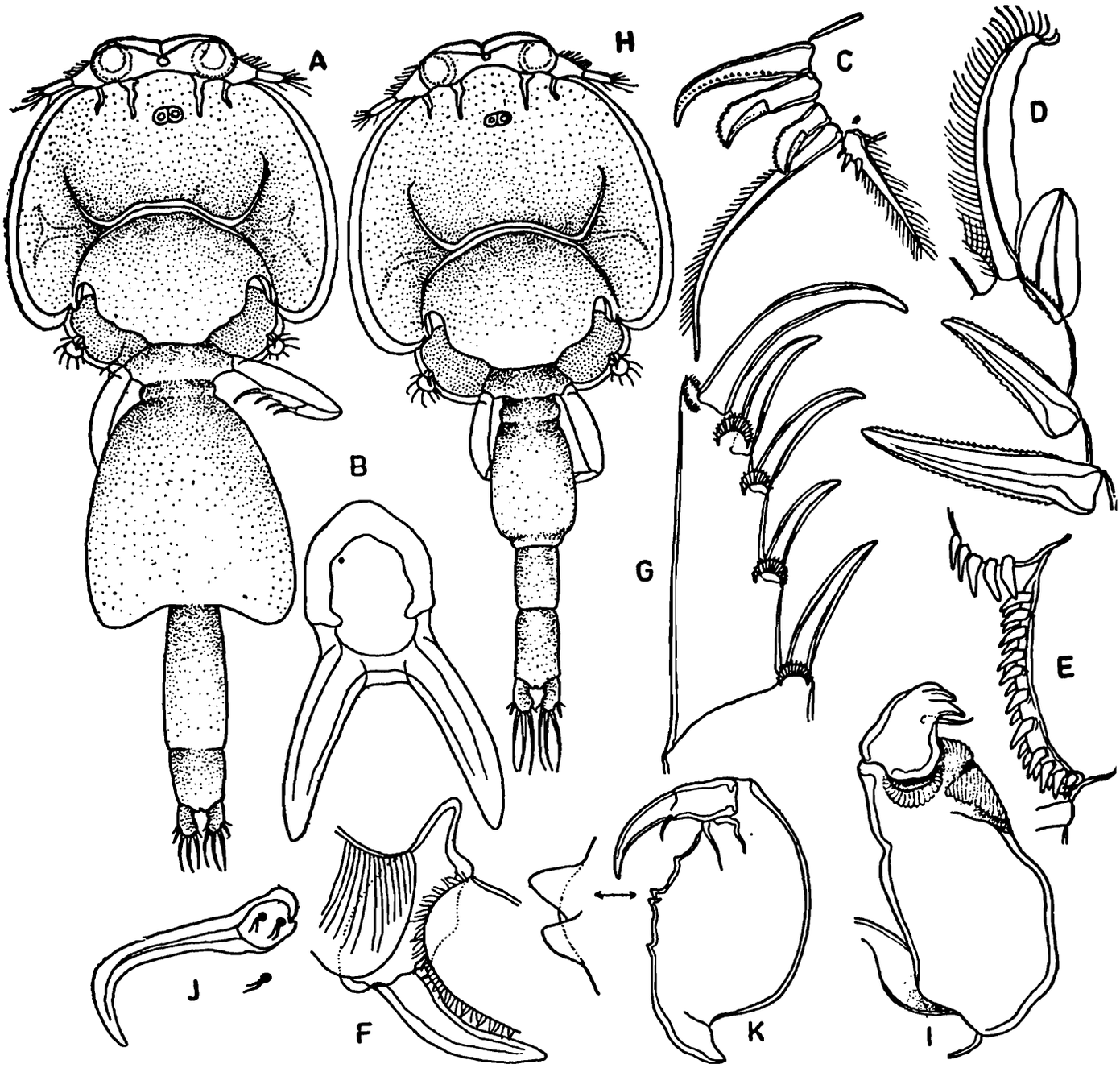


Fig. 77. *Caligus bonito* Wilson : A-G, Female. A, female, dorsal view ; B, sternal fork ; C, leg 1 ; D, leg 2, exopod ; E, same, endopod ; F, leg 3, basal process of exopod ; G. leg 4. H-K, Male. H, male, dorsal view ; I, antenna ; J. post-antennal process ; K, maxilliped.

triangular, slightly curved. One of the setae of maxillule very stout. Distal claws of maxilla short, well curved and prominently winged. Maxilliped slender. Sternal fork with narrow irregularly rounded base, limbs narrowing, strongly diverging.

Basipod of first leg spiny, first segment of exopod short but deep, its lower border with a row of denticles, distal segment with three

well developed lower setae, proximally toothed, spine-like seta very long, stout and dorsally plumose, claws stout, second and third with high serrate upper crest and large accessory process. First two claws of exopod of second leg large, with serrate wings, third small and spiny, first seta with broad wings. First segment of endopod with five strong teeth, second with about twenty teeth in two rows, third with one or two small teeth. Basal claw of exopod of third leg with large base and curved claw. Fourth leg three-segmented, claws stout and winged, last claw very stout.

*Length.*—3.0 mm.

*Male.*—Cephalothorax like that of female Genital segment very small. Abdomen two-segmented, segments subequal. Second segment of antenna very stout, with three distal pads, third segment short and cut into three teeth. Post-antennal process a long slender curved claw. Basal segment of maxilliped massive, its inner border with one double and two single teeth. Sternal fork with short rounded base and flat diverging apically rounded limbs.

*Length.*—2.0 mm.

*Host.*—*Gymnosarda pelamis, G. allterata, Pelamys sarda, Pomatomus saltatrix, Scomberomorus maculatus, S. cavalla, Lutianus novemfasciatus, L. griseus, Mugil cephalus, Oligoplites saurus, Euthynnus pelamis, E. lineatus, E. affinis, E. alleteratus, Cratinus agassizi, Sarda sarda, S. orientalis, S. velox, S. chilensis, Katsuwonus pelamis, Thunnus thynnus.*

*Distribution.*—Woods Hole, Mauritania, Genova, Florida, Japan, Mexico, Panama, Brazil, Louisiana, Texas, South Africa, Black Sea, Angola, California, India, Hawaii, South Pacific, Queensland.

*Remarks.*—After studying the types of *C. bonito* in the British Museum I suggested that *C. kuroshio* Shiino is the same as *C. bonito.* What prompted Shiino to create *C. kuroshio* is probably the defective description of *C. bonito* by Wilson.

Both Kabata and Lewis dealt with this matter. Kabata observed that in *C. bonito* the blade of the mandible is bilaterally serrated

which as I have pointed out earlier is not true. The other differences enumerated by Lewis are all minor especially since *C. bonito* is cosmopolitan in distribution.

## **Caligus brevicaudus** Pillai
## (Fig. 78)

*Caligus brevicaudus* Pillai, 1963f, p. 83, figs. 11-12 ; 1967d, p. 1589, fig. 66 ; Margolis *et al.*, 1975, p. 20.

*Female.*—Cephalothorax disproportionately large, nearly circular. Frontal plates low, with small lunules. Postero-median lobe of cephalothorax very slightly broader than lateral lobes and projecting well beyond the latter. Lateral lobes curving inwards and even overlapping median lobe, closing the posterior sinuses. Fourth segment fairly large. Genital segment pear-shaped. Abdomen two-segmented and very short, sunk into the genital segment, segmentation indistinct. Caudal rami very small.

Distal segment of antennule slender, longer than basal. Third segment of antenna very long and slender, strongly falcate. Post-antennal process a strong claw with ventral process and dorsal hump on its broad base. Post-oral process elongate triangular, with accessory process. Maxilliped very slender, second segment longer than basal, slender and strongly falcate. Sternal fork with stout rectangular base, limbs short.

First leg slender, distal segment with small spiny claws, spine-like seta long, smooth and curved, setae on lower border small. Outer border of basal segment of endopod of second leg with a crest of prominent spines, other segments hairy. Apron of third leg with adhesion pad and patches of strong spines, claw of exopod slender and strongly curved. Fourth leg slender, four-segmented, with short winged claws.

*Length.*—4.3 mm.

*Male.*—Cephalothorax like that of female. Fourth segment forming rounded lobes at the base of the legs. Genital segment small, only slightly broader than abdomen. Abdomen two-segmented, longer than broad. Distal segment of antennule very long.

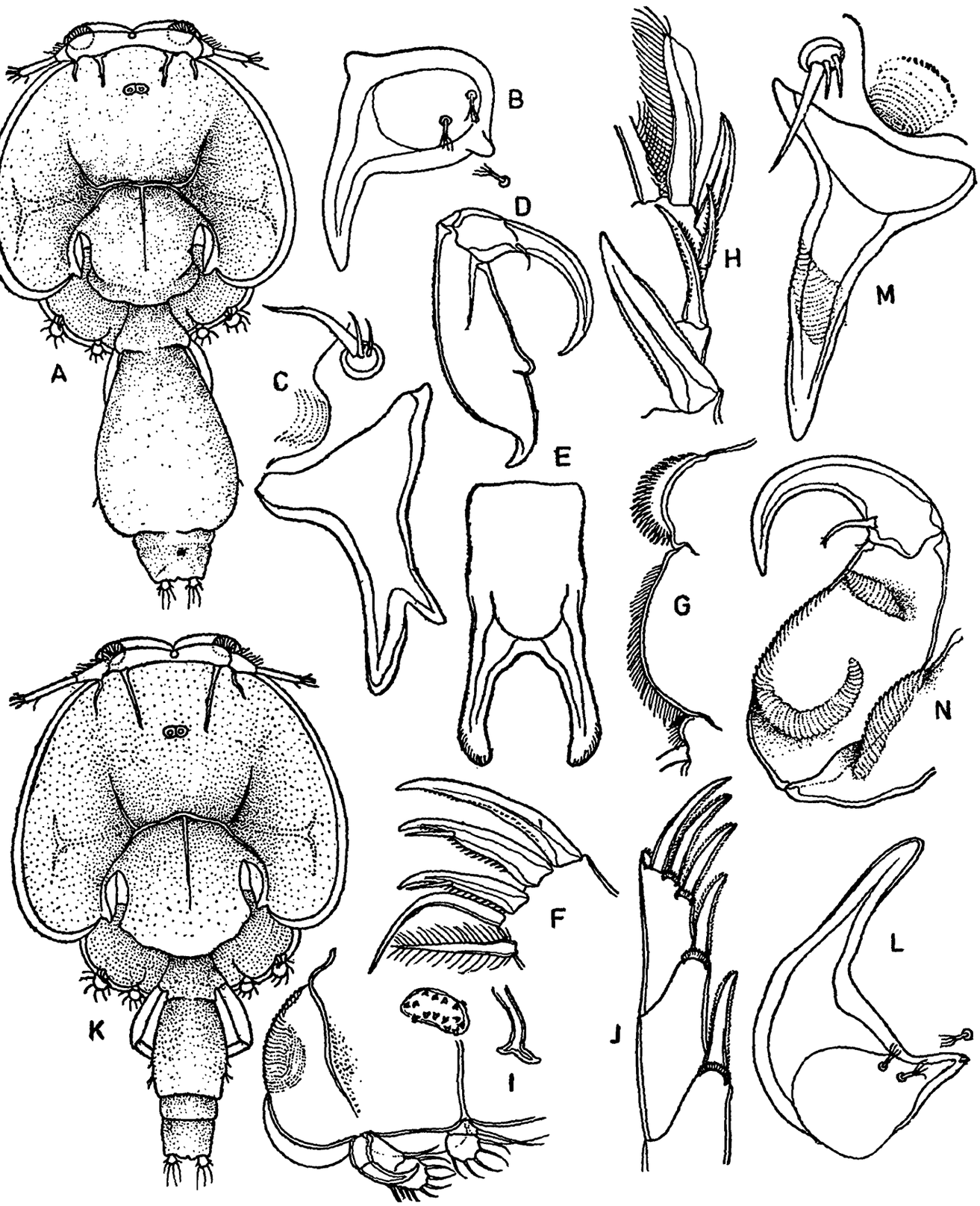


Fig. 78. *Caligus brevicaudus* Pillai : A-J. Female. A. female, dorsal view ; B, post-anntennal process ; C, post-oral process and maxillule ; D, maxilliped ; E, sternal forks ; F, leg 1 ; G, leg 2, endopod ; H, same, exopod ; I, leg 3 ; J, leg 4. K-N, Male. K, male, dorsal view ; L, post-antennal process ; M, post-oral process and maxillule ; N, antenna.

Basal segment of antenna with one and second with two adhesion pads, distal segment with swollen base carrying large spine-like seta. Post-antennal process large, with large accessory process. Post-oral process longer, without accessory process, but with median pad.

*Length.*—3.8 mm.

*Host.*—*Caranx* sp.

*Distribution.*—India (Kerala).

*Holotype* Female and *Allotype* male in the Indian Museum, Calcutta.

*Remarks.*—Species of *Caligus* parasitic on carangid fishes show surprising uniformity in their morphology. All have a nearly circular cephalothorax and short abdomen. The second segment of the antennule is long and slender, generally longer than the first. Third segment of the antenna is slender and strongly falcate. Maxilliped is very slender. First leg is slender, with small setae on last segment. Third leg has a strongly spiny apron, the basal claw of exopod is strongly curved. Basal segment of endopod of second leg has a crest of spines. Fourth leg is slender and four segmented. The post-antennal and post-oral processes generally have accessory processes. This combination of characters is seen in caligid parasites of carangids collected from every locality and provides a remarkable instance of adaptive convergence. It is significant that caligid parasites belonging to other genera parasitic on carangids also show this combination of characters.

## **Caligus chiloscyllii** (Pillai)
(Fig. 79)

*Caligus chiloscyllii* Pillai, 1967d, p. 1590, fig. 11 ; Margolis *et al.*, 1975, p. 22, *Caligus minutus* Pillai, 1963f, p. 87, fig. 13.

*Female.*—Cephalothorax nearly circular, with large projecting frontal plates. Lunules large and circular. Postero-median lobe of cephalothorax about four times as broad as lateral lobes, projecting well beyond the latter. Fourth segment large and clearly demarcated. Genital segment broadening backwards, postero-laterally rounded.

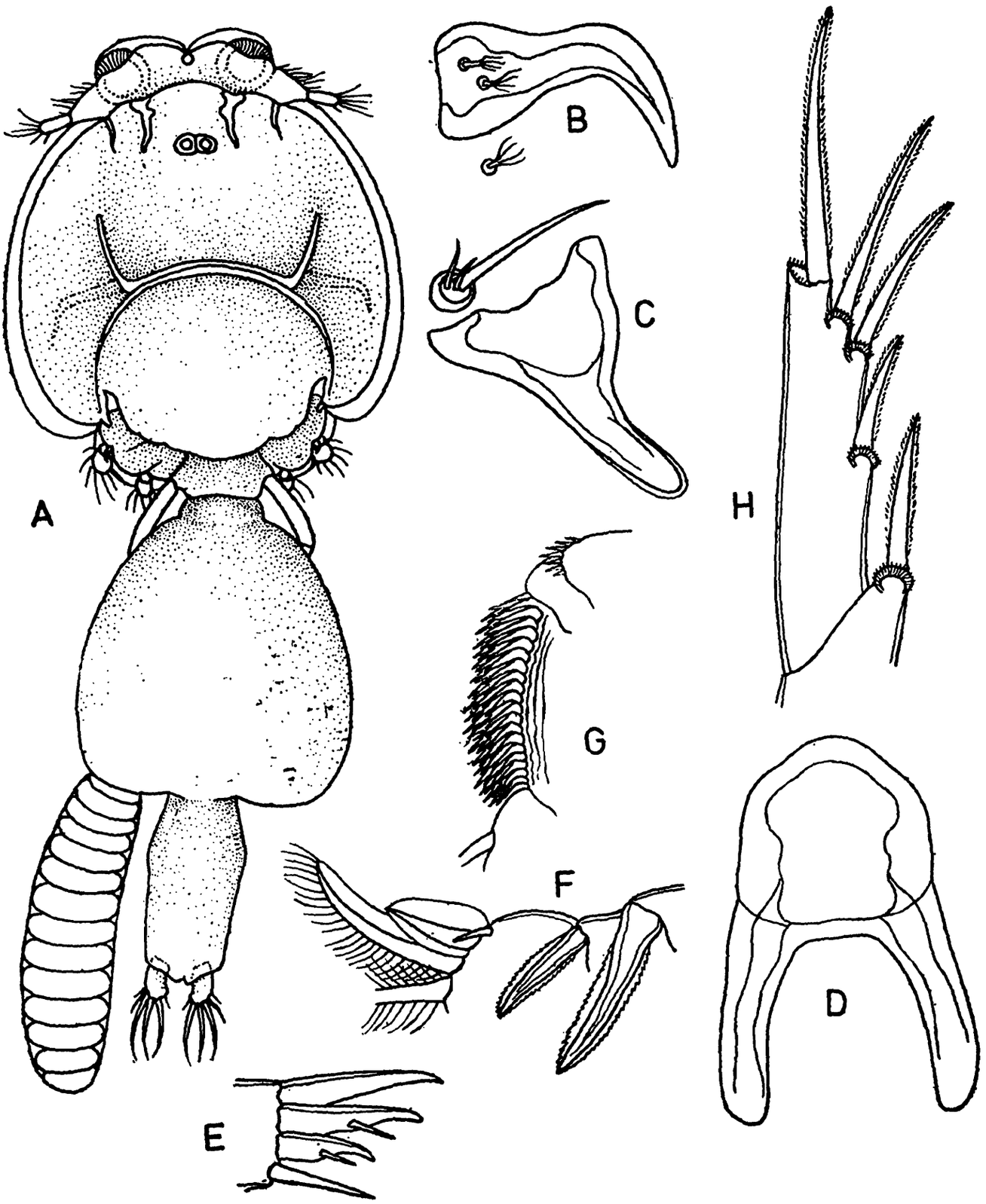


Fig. 79. *Caligus chiloscyllii* (Pillai) : A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 4.

Abdomen one-jointed, abruptly bulged at a third of the distance from base. Caudal rami large, longer than broad, overlapped by the abdomen.

Antenna strong, basal segment produced into a conical backwardly directed process. Post-antennal process short and sickle-shaped. Post-oral process apically rounded and fianged. One of the setae on maxillule very large. Maxilla and maxilliped normal. Sternal fork with broad rounded base, limbs slightly diverging and apically rounded.

Second segment of exopod of first leg with three nearly straight claws, second and third with small sharp accessory spine, spine-like seta straight, slightly longer than the third claw, lower border without setae. First two claws of exopod of second leg large, with broad serrate wings, third a small spine, first seta with broad wings. Basal segment of endopod with a row of seven spines, second segment with three rows of sharp bent teeth. Apron of third leg with outer part spiny, rami placed close together, basal claw of exopod nearly straight. Fourth leg three-segmented, with strong claws armed with finely serrate wings.

*Length.*—2.4 mm.

*Host.*—*Chiloscyllium indicum.*

*Distribution.*—India (Kerala).

*Holotype* Female in the National Zoological Collection at Zoological Survey of India, Calcutta, Reg. No. C2119/2.

**Caligus chrysophrysi** sp. nov.
(Fig. 80)

*Female.*—Cephalothorax gradually widening backwards, clearly longer than broad, postero-median lobe very broad, about four times as broad as lateral lobes and projecting far beyond the latter, posterior sinuses partially closed. Frontal plates deep and projecting, lunules comparatively inconspicuous. Fourth thoracic segment small, broader than long. Genital segment enlarged, pear-shaped, nearly equal in length and width. Abdomen one-segmented.

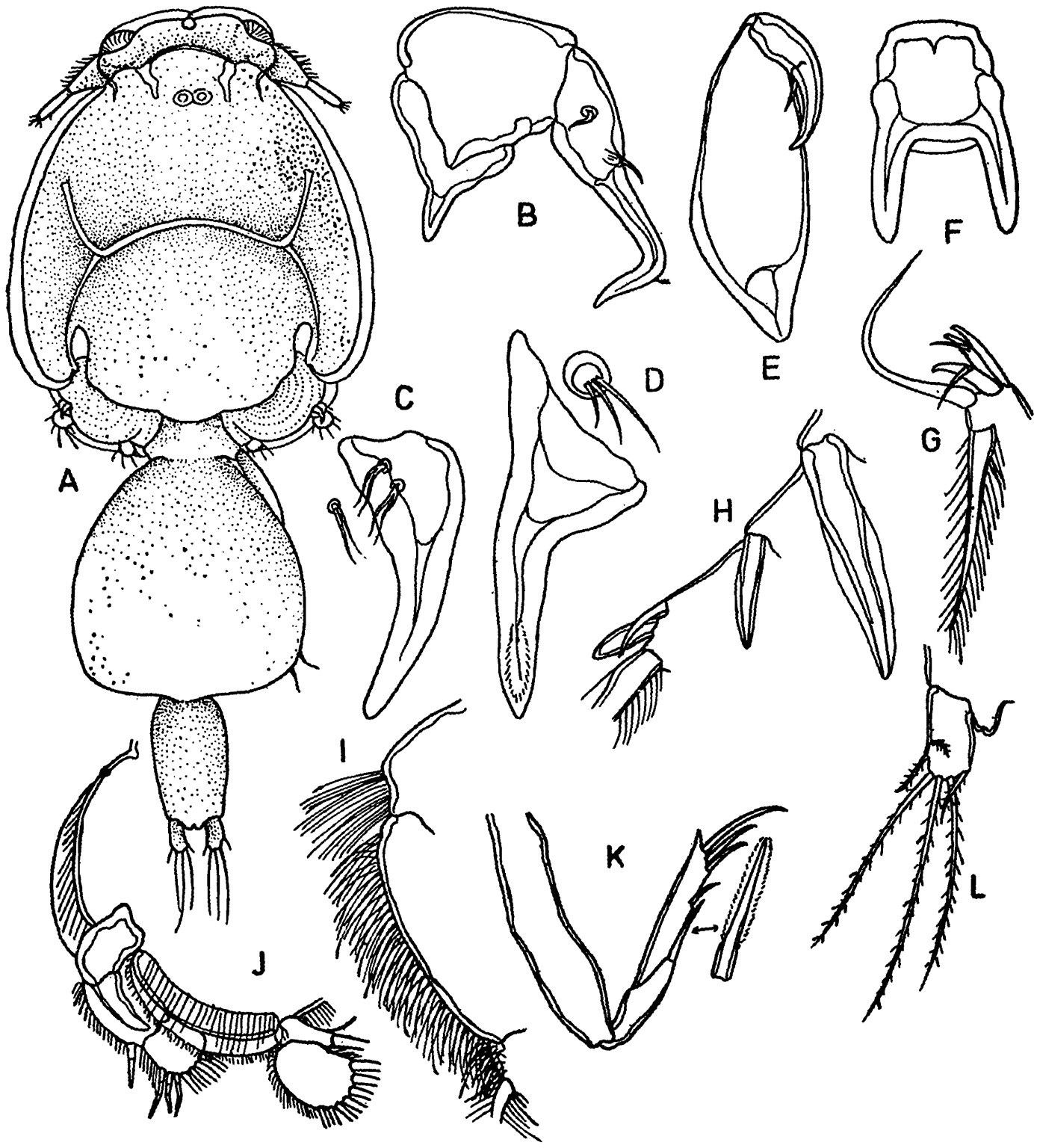


Fig. 80. *Caligus chrysophrysi* sp. nov. : A, female, dorsal view ; B, antenna C, post-antennal process ; D, post-oral process and maxillule ; E. maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, same, endopod ; J, legs 3 ; K, leg 4 ; L, caudal ramus.

about one and a half times as long as broad. Caudal rami prominent, with long slender setae.

Basal segment of antennule rather broad. Basal segment of antenna produced into a long apically rounded process, distal segment comparatively long, its swollen base carrying two setae, distally bent at right angles and apically curved outwards. Post-antennal process elongate-triangular and rather stout, associated with three large bifid setae. Post-oral process large, with broad base and slightly narrowing claw with a sharp bend near base. Maxilla normal. Distal segment of maxilliped small, with a long seta. Sternal fork with large base, limbs subparallel and almost of the same width throughout, apically rounded.

Distal segment of first leg with three very long lower setae, spine-like seta naked, as long as the nearest lower seta, claws subequal in size, second and third with long accessory process. Outer border of endopod of second leg hairy, claw on first segment of exopod large and winged, that on second segment similar to first but smaller, third slender, long and slightly curved, first seta modified into a short stout process as long as the third claw. Rami of third leg situated wide part, basal claw of exopod incurved. Fourth leg slender, three-segmented, claws slender and winged, last claw one and a half times as long as the penultimate.

*Length.*—2.1 mm.

*Host.*—*Chrysophrys sarba.*

*Distribution.*—India (Kerala).

*Holotype* Female, the only specimen available, in the National Zoological Collection at Zoological Survey of India, Calcutta, Reg. No. C2120/2.

*Remarks.*—This is a commonplace species but in practically every one of its characters there is some individuality. Of these particular mention may be made of the stout post-oral process, widely set, nearly parallel limbs of the sternal fork, the shape and size of the claws on the exopod of the second leg, the long hairs that fringe the outer border of the segments of the endopod of the second let, the armature of the distal segment of the first leg and the extremely long and slender setae on the caudal rami.

## **Caligus clavatus** Kirtisinghe

(Fig. 81)

*Caligus clavatus* Kirtisinghe, 1964, p. 63, figs. 51-56 ; Pillai, 1967d, p. 1576, fig. 35 ; Margolis *et al.*, 1975, p. 23.

*Caligus sphyraeni* Pillai, 1963f, p. 90, fig. 15 (nec Nunes-Ruivo and Fourmanoir 1956).

*Female.*—Cephalothorax subcircular, broadest behind. Frontal plates fairly well developed, lunules of average size but rather indistinct. Postero-median lobe only slightly broader than lateral lobes, only slightly projecting beyond the latter. Fourth segment traingular, expanded at the base of the legs. Genital segment large like a narrow-mouthed jar, with short distinct anterior neck. Abdomen nearly as long as genital segment, slighly asymmetrical, elongate-oblong and apparently two-segmented, segmentation indistinct. Caudal rami small, slightly longer than broad.

Basal segment of antenna with a blunt process, distal segment long, slender and apical curved. Post-antennal process sharply bent beyond base. Post-oral process elongate traingular. Maxillule with rather long setae. Basal segment of maxilliped stout but unarmed, distal rather slender. Sternal fork with roughly rectangular base, limbs as long as base, irregular, subparallel and apically rounded.

First leg short and stumpy, distal segment with small ventral setae, claws irregular, ventrally barbed, second and third with accessory process, spine-like seta shorter than the third claw. Claws of exopod of second leg strong and spiny, first two setae modified, first with smooth dorsal and serrate ventral Hing. Basal segment of endopod with a crest of closely packed spines, second segment hairy. Apron of third leg with a long patch of spines in line with the exopod and an outer adhesion pad, rami nearly overlapping, basal claw of exopod sickle-shaped. Fourth leg four-segmented, distal three segments subequal in length, with subsimilar claws.

*Length.*—3.4 mm.

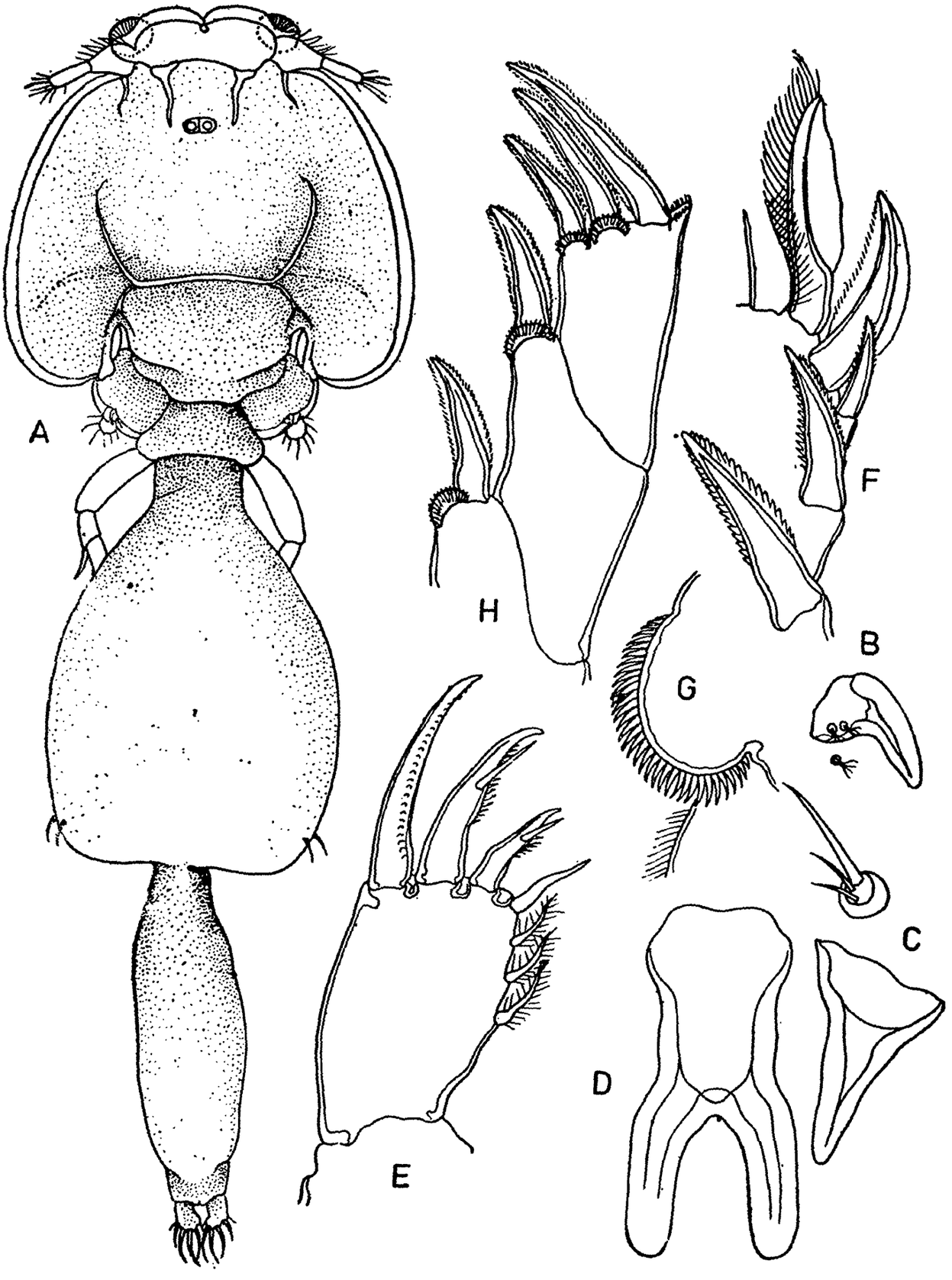


Fig. 81. *Caligus clavatus* Kirtisinghe : A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 : F, leg 2, exopod ; G, same, endopod ; H, leg 4.

*Host.—Sphyraena acutipinnis, S. obtusata.*

*Distribution.*—Sri Lanka, India (Kerala).

*Holotype*—Female in National Zoological Collection at Z.S.I. Calcutta. Reg. No. C2121/2.

*Remarks.*—Kirtisinghe compared this species with *C. dussumieri* Rangnekar. But apart from the shape of the abdomen these two species are totally different. The sternal fork as illustrated by Kirtisinghe is very much different from that of my specimens. The limbs of the fork are parallel and not diverging.

*C. clavatus* can be easily distinguished by the somewhat distorted abdomen. Even the claws and setae on the appendages exhibit this distortion or irregularity.

## **Caligus confusus** Pillai
(Fig. 82)

*Caligus confusus* Pillai, 1961, p. 104, fig. 10 ; 1963f, p. 83 ; 1967d, p. 1580, fig. 44, ; Kirtisinghe, 1964, p. 68, figs. 70-71 ; Kabata, 1968b, p. 9, fig. 3 ; Lewis 1968, p. 53, figs. 22-23 ; Margolis *et al.*, 1975, p. 23.
*Caligus alalongae* Kirtisinghe, 1937a, p. 435, figs. 1-14 (nec Kroyer, 1863).
*Caligus constructus* Wilson, 1937, p. 428 fig. 1-5 ; Shiino, 1959d, p. 285, figs. 9-10 (nec Heller, 1868).

*Female.*—Cephalothorax large, nearly circular. Frontal plates low, lunules moderately large. Postero-median lobe only slightly broader than lateral lobes, latter curving inwards and overlapping median lobe and closing the posterior sinuses. Fourth thoracic segment large, produced into rounded lobes overlapping the base of the legs. Genital segment swollen, with anterior narrow neck, postero-laterally produced into well rounded lobes. Abdomen short, one-segmented and nearly rounded. Caudal rami very small.

Distal segment of antennule long and slender. Basal segment of antenna with blunt process, distal segment long and slender. Post-antennal process large, irregular, with basal accessory process, claw flattened. Post-oral process with proximal inner broad hump followed by a conical process, claw flat, apically rounded Sternal fork with squarish base, limbs parallel, inner borders diverging.

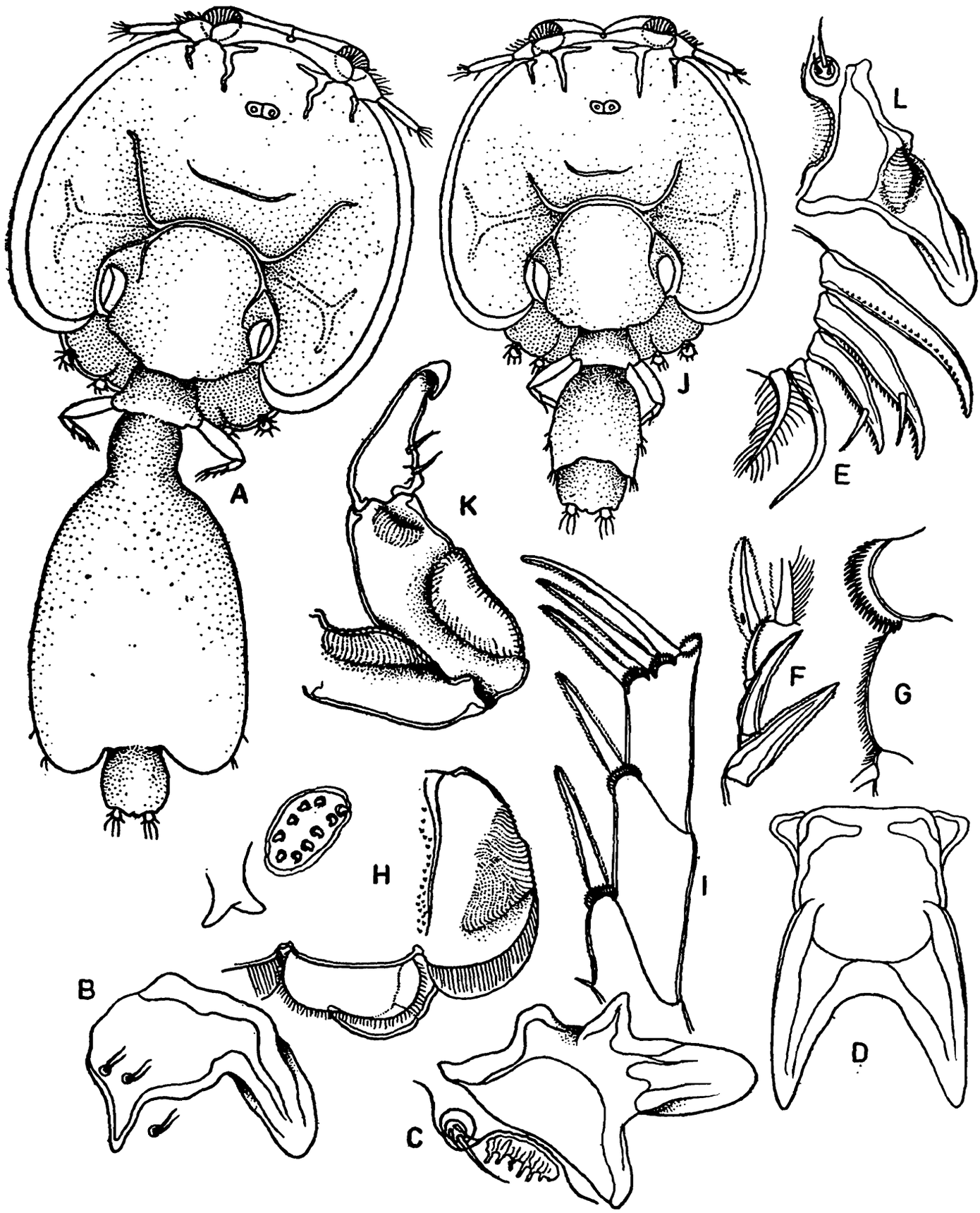


Fig. 82. *Caligus confusus* Pillai : A-I, Female. A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 3 ; I, leg 4. J-L, Male. J, male, dorsal view ; K, antenna ; L, post-oral process and maxillule.

Distal segment of first leg with slender claws, second and third with accessory process, spine-like seta long, smooth and curved, ventral setae comparatively small. Claws on exopod of second leg with serrate wings, modified setae alus with serrate wings. Basal segment of endopod with a prominent crest of spines, second and third segments hairy. Apron of third leg with outer adhesion pad, a long row of denticles above the exopod, a circlet of strong teeth above endopod and an apically bifid projecting rib inner to it, basal claw of exopod strongly curved. Fourth leg four-segmented, distal three segments subequal in length, with five subsimilar claws.

*Length.*—2.9 mm.

*Male.*—Cephalothorax similar to that of female, postero-median lobe slightly narrower. Genital segment together with the broad one-segmented abdomen oblong. Antenna modified, basal segment with one and second with two adhesion pads, third segment long. Post-oral process without hump, accessory process very small, median ventral adhesion pad present. Basal segment of maxilliped with inner distal nodule.

*Length.*—1.8 mm.

*Host.*—*Caranx sansun*, *C. hippos*, *C. melampygus*, *Coryphaena hippurus*, *Caranx* sp., *Seriola* sp.

*Distribution.*—Sri Lanka, India (Kerala), Panama, Galapagos, Celebes, Japan, Costa Rica, Marshall Islands.

*Holotype* female and *Allotype* male in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. Nos. C 2122/2 & C 2123/2.

*Remarks.*—Kabata upheld the synonymy of this species proposed by me but Lewis expressed some reservations. As observed by Lewis the post-antennal process, post-oral process and the sternal fork are flattened and not winged. But the post-oral process is quite different from that illustrated by Lewis. The sternal fork and abdomen of the female illustrated by Lewis are also different. The difference in size mentioned by Lewis has no significance since such variations are common among parasitic copepods.

Lewis questioned my action of placing *C. Constrictus* of Shiino and Wilson in the synonymy of *C. confusus*. But I still feel that my action is justifiable.

## **Caligus constrictus** Heller

(Fig. 83)

*Caligus constrictus* Heller, 1968, p. 175, pl. 15, fig. 5 ; Kirtisinghe, 1956, p. 14, figs. 1-4 ; 1964, p. 54, figs, 27-28 ; Pillai, 1961, p. 93, fig. 4; 1967d, p. 1580, fig. 58 ; Margolis *et al.*, 1975, p. 23.

*Midias carangis* Rangnekar, 1956, p. 49.

*Female.*—Cephalothorax comparatively large, frontal plates projecting, postero-median lobe twice as broad as lateral lobes, hardly projecting beyond the latter, its distal border trilobed, posterior sinuses fully open. Fourth segment produced over the base of the legs. Genital segment enlarged, broadening backwards. abdomen two-segmented, first segment highly swollen and narrowing backwards, second small, slighlly broader than long. Egg sacs short.

Distal segment of antennule long and slender. Basal segment of antenna with small rounded process, distal long, slender and apically curved. Post-antennal process a broad-based claw with dorsal hump. Post-oral process elongated and distally flanged, with small accessory process. One of the setae of maxillule long. Distal claws of maxilla large. Basal segment of maxilliped large, distal slender and strongly curved. Sternal fork with bracket-shaped blunt limbs.

Distal segment of first leg with three short setae, three long ventrally spiny claws and a naked spine-like seta slightly longer than the first claw, second and third claws with accessory process. First two claws of exopod of second leg large and winged, third a sharp spine, basal segment of endopod with a crest of spines. Apron of third leg with outer adhesion pad, a long patch of teeth and a circlet of teeth, basal claw of exopod irregular and strongly curved.

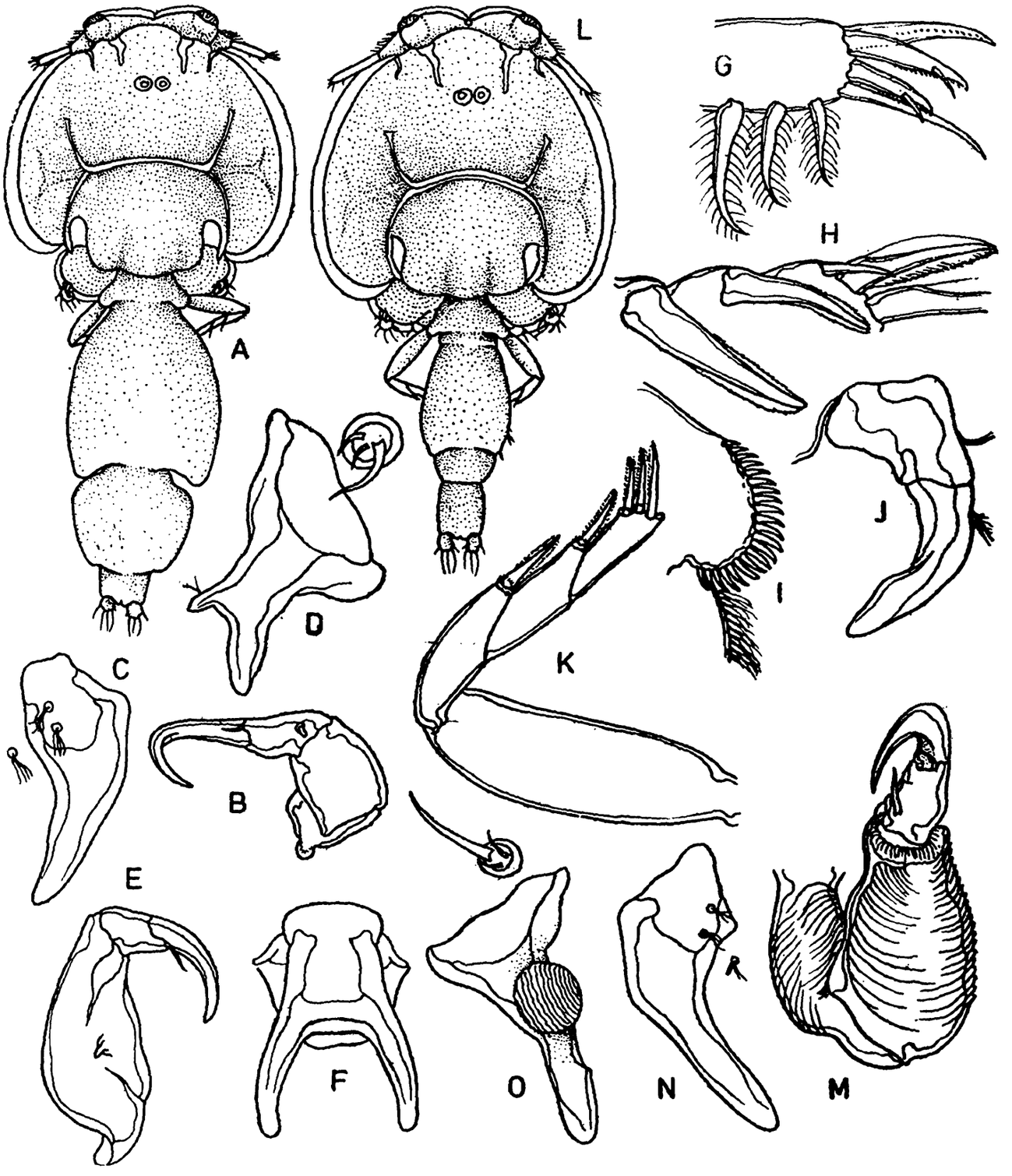


Fig. 83. *Caligus constrictus* Heller : A-K, Female. A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, same, endopod ; J, leg 3, basal process of exopod ; K, leg 4, L-O, Male. L, male, dorsal view ; M, antenna ; N, post-antennal process ; O, post-oral process and maxillule.

*Male.*—Cephalothorax broadening backwards, lateral lobes curving inwards and closing the posterior sinuses ; fourth segment triangular, genital segment with anterior constriction, slightly longer than broad and gradually widening backwards, abdomen subequal to genital segment in length, two-jointed, first segment shorter, narrowing backwards.

Basal segment of antenna with one and second with two adhesion pads, almost fully covering the ventral side, third segment long and recurved. Post-antennal process longer and more slender than in female. Post-oral process without accessory process but with an adhesion pad.

Fourth leg four-segmented.

*Length.*—3.8 mm.

*Host.*—*Stromateus* sp., *Alectis indicus*, *Carangoides malabaricus*.

*Distribution.*—Indian Ocean (Sri Lanka, Bombay, Kerala).

*Remarks.*—This species shows some resemblance to *C. confusus* especially since both are parasites of carangids. But they can be easily distinguished by the shape of the abdomen, post-antennal process, post-oral process and the sternal fork. Rangnekar was mislead by the description of dorsal plates on the fourth segment of *Midias* by Wilson. She probably mistook the expansion at the base of the legs for dorsal plates. But her illustration of the female shows the plates at the wrong place.

### **Caligus cordyla** Pillai

(Fig. 84)

*Caligus cordyla* Pillai, 1963f, p. 77, fig. 10 ; 1967d, p. 1588, fig. 65 ; Margolis *et al.*, 1975, p. 24.

*Female.*—Cephalothorax elegantly rounded, frontal plates deep and much projecting. Postero-median lobe as broad as lateral lobes and not projecting much, making the hind border trilobed. Posterior sinuses closed behind. Fourth segment produced over

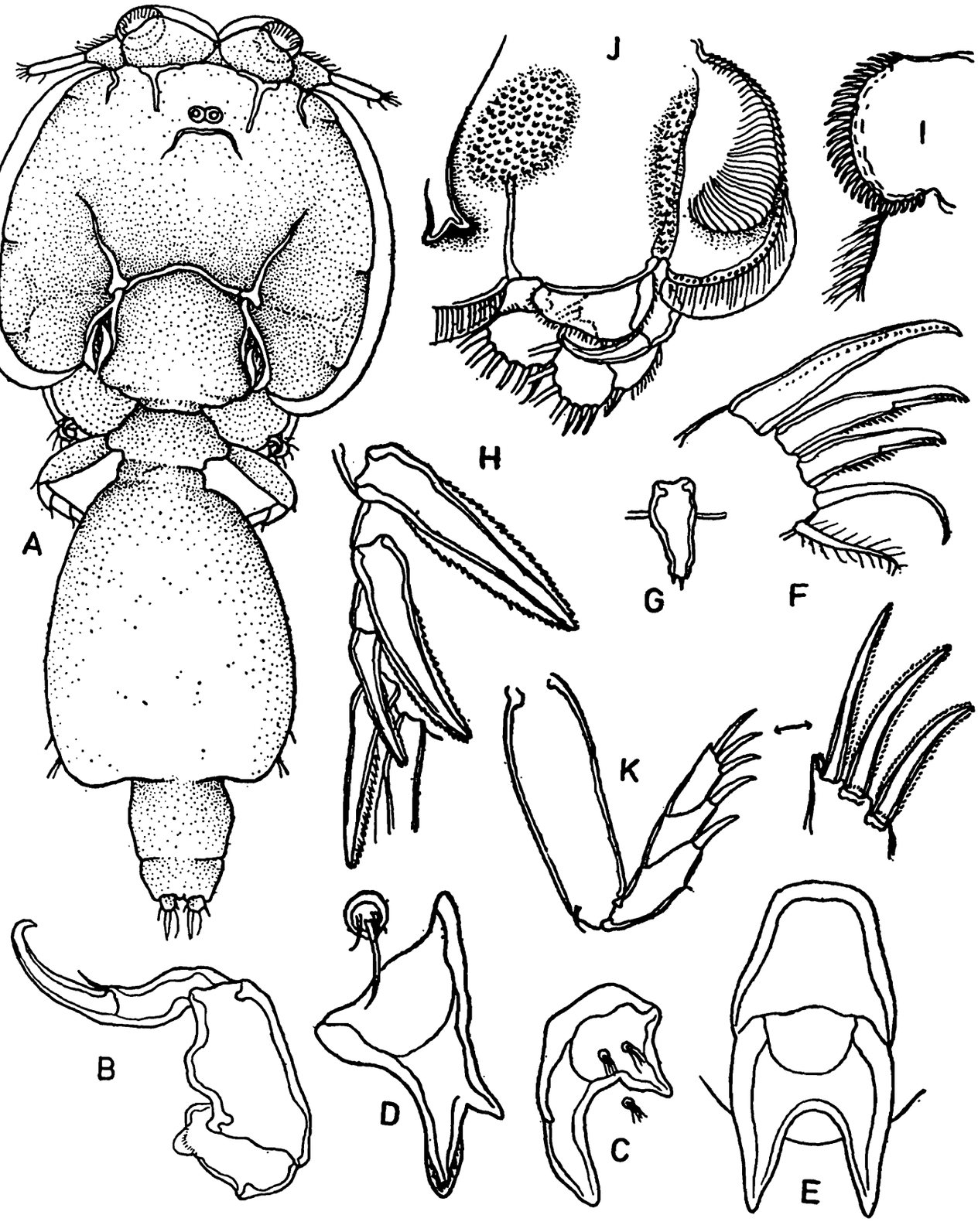


Fig. 84. *Caligus cordyla* Pillai : A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, sternal fork ; F, leg 1 ; G, same, vestigial endopod ; H, leg 2, exopod ; I, same, endopod ; J, leg 3 ; K, leg 4.

the base of the legs. Genital segment widening backwards, postero-laterally rounded. Abdomen short, indistinctly two-segmented, segments swollen. Caudal rami very small.

Distal segment of antennule long and slender. Basal segment of antenna with small rounded process, distal slender and well curved. Post-antennal process a strongly curved irregular claw, base with a process. Post-oral process triangular and distally flanged, with small accessory process. Maxilla slender, claws prominently winged. Baxal segment of maxilliped moderately stout, distal segment slender, with a short spine-like seta. Sternal fork with large swollen base, limbs apically narrowed, inner borders diverging.

Vestigial endopod of first leg indistinctly two-segmented, with two apical spinules, distal exopod segment with three slender irregular barbed claws, second and third with accessory process, spine-like seta naked, as long as first claw, ventral setae small. Claws on exopod of second leg with broad serrate wings, successively decreasing in size, first seta large, with ventral serrate wing, basal segment of endopod with a high crest of spines, second and third segments hairy. Apron of third leg with outer adhesion pad, two patches of spines and a projecting bifid chitinous rib, basal claw of exopod slender and strongly curved. Fourth leg slender, four-segmented, with five subsimilar winged claws.

*Length.*—3.0 mm.

*Male.*—Cephalothorax similar to that of female. Fourth segment as long as broad. Genital segment and abdomen comparatively small. Antenna large, second segment with inner surface almost fully covered by a large adhesion pad and an arcuate pad near the insertion of the slender, unmodified distal segment. Post-oral process with broader flange and an adhesion pad. Basal segment of maxilliped internally produced into four low teeth, distal segment with a long spine.

*Length.*—2.0 mm.

*Host.—Megalaspis cordyala.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2124/2.

*Remarks.*—This species closely resembles other parasitic on carangid fishes but can be distinguished by the general shape of the body, the sternal fork and the antenna of the male.

## **Caligus cornutus** Heegaard

(Fig. 85)

*Caligus cornutus* Heegaard, 1962, p. 164, figs. 92-98 ; Kirtisinghe, 1964, p. 72 ; Kabata, 1965f, p. 109 ; Pillai, 1966, p. 130, fig. 5 ; 1967d, p. 1584, fig. 54 ; Margolis *et al.*, 1975, p. 24.

*Caligus spinosus* Pillai, 1963f, p. 76, fig. 6 (nec Yamaguti, 1939f; Shiino, 1960a).

*Female.*—Cephalothorax slighly longer than broad, frontal plates deep, lunules of moderate size. Posteromedian lobe one and a half times as broad as laternal lobes but hardly projecting beyond them. Posterior sinuses deep and closed behind. Genital segment swollen, one and a half times as long as broad, postero-laterally angular. Abdomen short, indistinctly two-jointed and swollen, exactly like that of *C. cordyla* Pillai. Caudal rami small, sunk into the abdomen.

Distal segment of antennule long and slender. Basal segment of antenna with a short blunt process, distal segment long, slender and apically curved. Post-antennal process a small slightly curved claw. Post-oral process triangular, with small accessory process. Maxilla and maxilliped weak. Sternal fork small, with narrowing and diverging limbs, distally curving inwards.

Distal exopod segment of first leg with three ventrally barbed claws, second and third with accessory process, spine-like seta short and naked, ventral setae normally developed, apices of the claws blunt and cut into lobes as in *Midias lobodes.* Claws on exopod of second leg successively decreasing in size, with serrate wings. First segment of endopod with a row of short teeth, second and third hairy. Outer part of apron on third leg with small adhesion pad and two rows of denticles and a patch of spines. Basal claw of exopod

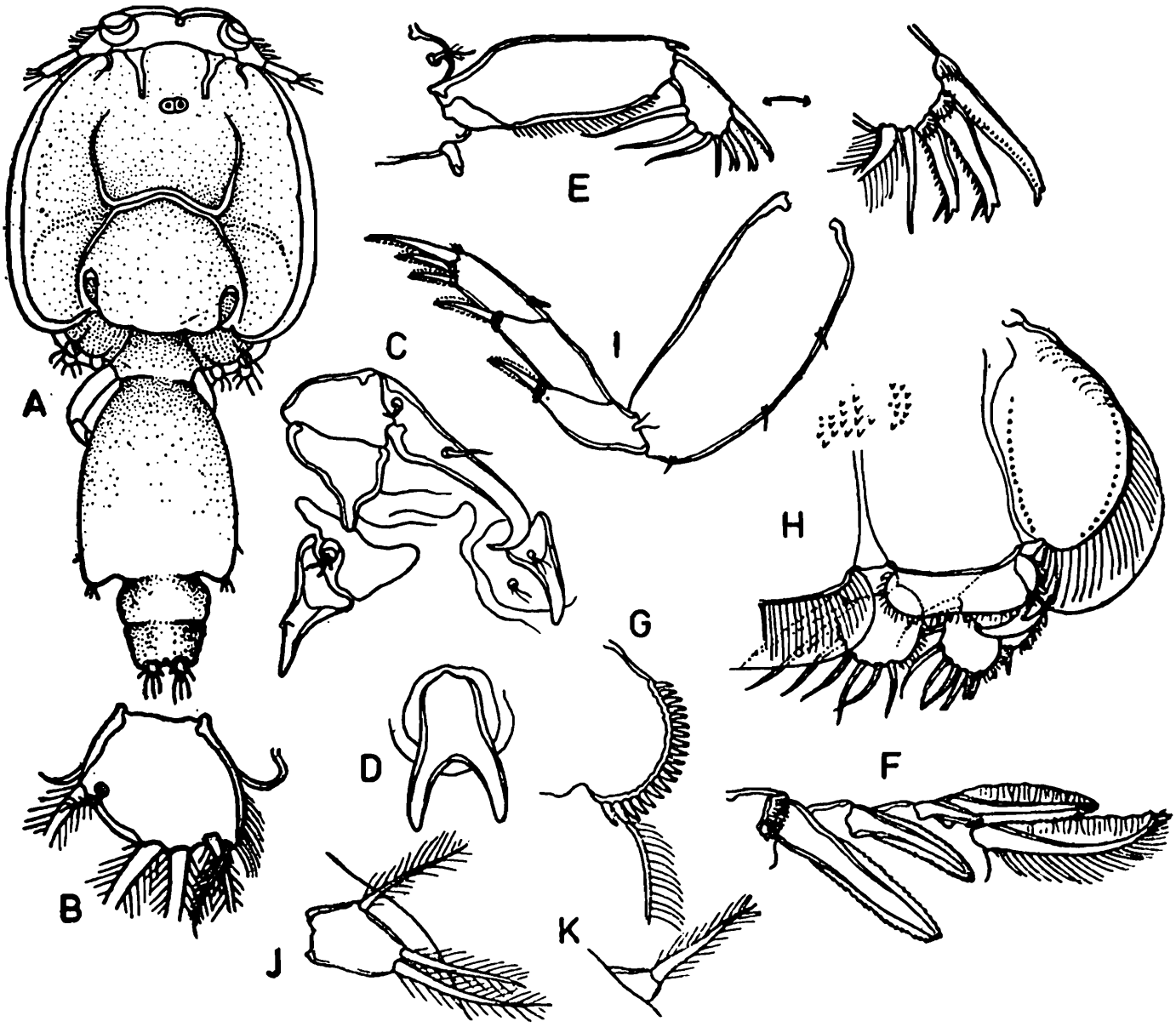


Fig. 85. *Caligus cornutus* Heegaard : A, female, dorsal view ; B, caudal ramus ; C, antenna, post-antennal process and post-oral process ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 3 ; I, leg 4 ; J, leg 5 ; K, leg 6.

slender and strongly curved, with prominent accessory claw. Fourth leg four-segmented, basal segment broad. claws one to four similar fifth longer.

*Length.*—5.1 mm.

*Host.—Sphyraena jello, S. obtusata.*

*Distribution.*—Queensland, India (Kerala).

*Remarks.*—*C. cornutus* shows very close similarity to *Midias lobodes* Wilson in the shape of the cephalothorax, swollen basal segment of the abdomen and the distally lobed distal segment. As in *M. lobodes* the distal claws on the first leg are apically cut into lobes, basal claw of the exopod of third leg has a prominent accessory process and the basal segment of the fourth leg is broad. *C. cornutus* thus shows all the characters of *Midias* but is a true *Caligus*. This shows that there is no reason why *Midias* should not be made a synonym of *Caligus*.

## **Caligus coryphaenae** Stp. & Lutk.

(Fig. 86)

*Caligus coryphaenae* Stp. Lutk., 1861, p. 360, pl. 4, fig. 7 ; Bassett-Smith, 1899, p. 451 ; Wilson, 1905a, p. 556 ; Heegaard, 1949, p. 241, figs. 6-10 ; Capart, 1959, p. 81, fig. 14 ; Shiino, 1959a, p. 2, figs. 1-2 ; 1959d, p. 294, fig. 12 ; Kurian, 1961, p. 68, figs. 16-24 : Pillai, 1963b, p. 513, figs. 1-2 ; Yamaguti, 1963, p. 51, pl. 49, fig. 3 ; Lewis, 1967, p. 101. figs. 37-39 ; Margolis *et al.*, 1975, p. 25.

*Caligus bengoensis* Scott, 1894, p. 130, pl. 14, fig. 19.

*Caligus aliuncus* Wilson, 1905a, p. 576, pl. 9.

*Caligus elongatus* Heegaard, 1943b, 11 p. figs. 21-31.

*Caligus tesserifer* Shiino, 1952, p. 89, fig. 5.

*Female.*—Cephalothorax longer than broad, postero-median lobe about three times as broad as lateral lobes, nearly squarish. Fourth thoracic segment short, as broad as median lobe of cephalothorax. Genital segment large, antero-laterally shoulder-like, gradually widening backwards and postero-laterally forming two small apically rounded conical lobes. Abdomen longer than genital segment, five-segmented, first two septa often incomplete, Caudal rami sunk into the abdomen, each with three large apical setae, a spine-like outer seta and two small setae.

Antennue short but stout, two of the setae on basal segment and five on the distal segment very long and plumose. Antenna stout and strong. Post-antennal process absent. Post-oral process traingular. Maxilla and maxilliped normal. Sternal fork with short narrow base, limbs stout, winged and prominently diverging.

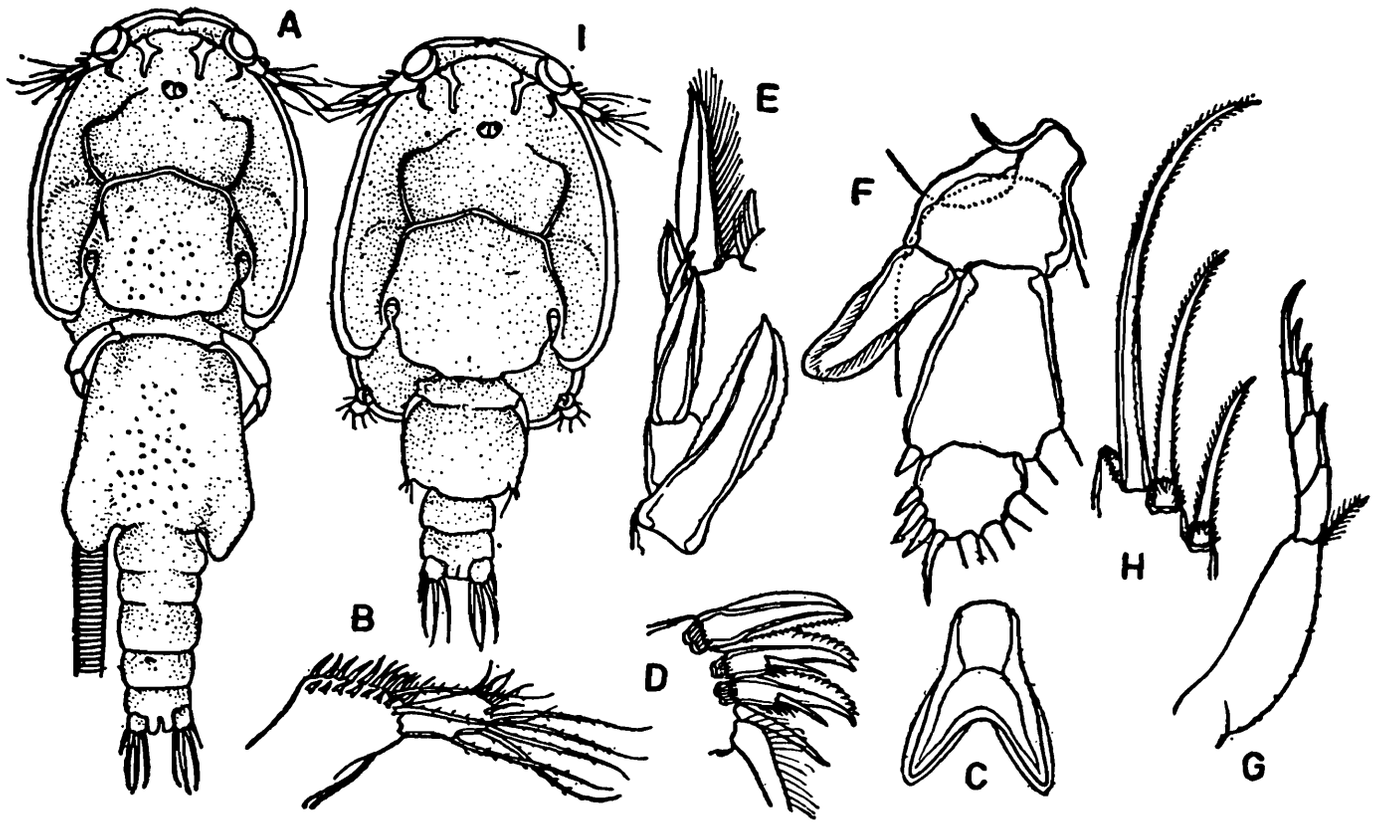


Fig. 86. *Caligus coryphaenae* Stp. & Lulk. : A-H, Female. A, female, dorsal view; B, antennule; C, sternal fork; D, leg 1; E, leg 2, exopod ; F, leg 3, basal process of exopod ; G, leg 4 ; H, same, tip enlarged, I, male, dorsal view.

Distal segment of first leg with three stout well armed claws, first claw with smooth dorsal wing and serrate ventral wing, second and third with high serrate dorsal crest, a short serrate ventral flange and an accessory claw, spine-like seta small, ventral setae large. First two claws of exopod of second leg strout and winged, third small and naked. Basal claw of exopod of third leg blunt, nearly straight and with broad wings, slightly bent outwards at the apex. Fourth leg four-jointed, last claw about one and a half times as long as the penultimate, curved inwards.

*Length.*—6.5 mm.

*Male.*—General shape as in female. Genital segment small, with prominent lobes carrying the vestigial legs. Abdomen short and two-segmented. Third segment of antenna with an accessory claw.

*Length.*—5.0 mm.

*Host.*—*Coryphaena hippurus, C. pelagica, Parathunnus obesus, P. sibi, Euthynnus alleteratus, E. yaito, R. lineatus, E. affinis, Sarda orientalis, Katsuwonus pelamis, Squalus acanthias, Neothunnus albacora, N. macropterus, Seriola dorsalis, Rachycentron canadus, Caranx hippos, C. melampygus, Isurus glaucus, Thunnus thynnus, Acanthocybium solandri, Echeneis* sp., *Sphaeroides inermis, Grammatorcycnus bilineatus, Elegatis bipinnulatus.*

*Distribution.*—Tropical and subtropical waters of all oceans including the Mediterranean.

*Remarks.*—This widely distributed species has a well chitinised body. The distal segment of the antennule carries exceptionally long setae which are plumose, a character which is unusual in caligids. The armature of the distal segment of the first leg is very characteristic and distinguishes this species from most species of *Caligus*. The five-jointed abdomen is unique.

## **Caligus cossacki** Bassett-Smith

*Caligus cossacki* Bassett-Smith, 1898b, p. 85, pl. 4, fig. 3 ; Heegaard, 1943b, p. 1, fig. 12 ; Barnard, 1955, p. 244, fig. 8 ; Kirtisinghe, 1964, p. 57 ; Pillai, 1967d, p. 1590, fig. 81 ; Margolis *et al.*, 1975, p. 26.

*Host.*—*Rhabdosargus sarba, Acanthopagurus berda.*

*Distribution.*—Sri Lanka, Madagascar, South Africa, Persian Gulf.

*Remarks.*—I have not seen specimens of this species and there is yet no good description available. The following summary of characters is from the description provided by Heegaard (1943).

Cephalothorax slightly longer than broad, broadening backwards, median lobe about three times as broad as lateral lobes and evenly rounded. Frontal plates projecting, with prominent lunules. Fourth segment much broader than long. Genital segment enlarged, with subparallel sides, antero-lateral and postero-lateral parts well rounded. Abdomen as long as genital segment, first segment longer than second. Caudal rami nearly squarish.

Distal segment of antenna very slender and distally curved. Post-antennal process a long slender curved claw. Heegaard describes an additional structure fused with the base of the process having a two-jointed palp ? Post-oral process long and slender. Distal segment of maxilla long and very slender. Heegaard describes a spine at the distal part of the basal joint ? Second segment of maxilliped very slender. Sternal fork with narrow base, libs first diverging and apically converging.

Distal segment of first leg with three claws successively decreasing in length, spine-life seta long and plumose, ventral setae normal. Fourth leg three-segmented, with five claws, second to fifth successively increasing in length.

*Length.*—3.2 mm.

*C. cossacki* described by Rangnekar and Murti (1959) certainly has some resemblance to *C. cossacki* Bassett-Smith as described by Heegaard but lacks setae on the ventral border of the distal segment of first leg. This alone is sufficient to show that their identification is wrong.

## **Caligus cybii** Bassett-Smith

(Fig. 87)

*Caligus cybii* Bassett-Smith, 1898a, p. 16, pl. 2, fig. 3 ; 1899, p. 452 ; Wilson, 1905a, p. 558 ; Yamaguti, 1963, p. 51 ; Kirtisinghe, 1964, p. 58 ; Pillai, 1967d. p. 1578, fig. 38, 1969, p. 156, figs. 35-47 ; Silas and Ummerkutty, 1967, p. 877 ; Margolis *et al.*, 1975, p. 27.

*Caigus brevisoris* Pillai, 1961, p. 87, fig. 1 (*nec* Shen, 1957b).

*Female.*—Cephalothorax nearly circular, frontal plates low, with very small lunules, postero-median lobe about twice as broad as lateral lobes and only slightly projecting beyond the latter. Lateral lobes curving inwards and partially closing the posterior sinuses. Fourth thoracic segment produced at the base of the legs as rounded lobes, indistinguishably fused with the genital segment. Latter swollen, roughly hemispherical, antero-laterally rounded and postero-laterally angular. Abdomen very long, as long as

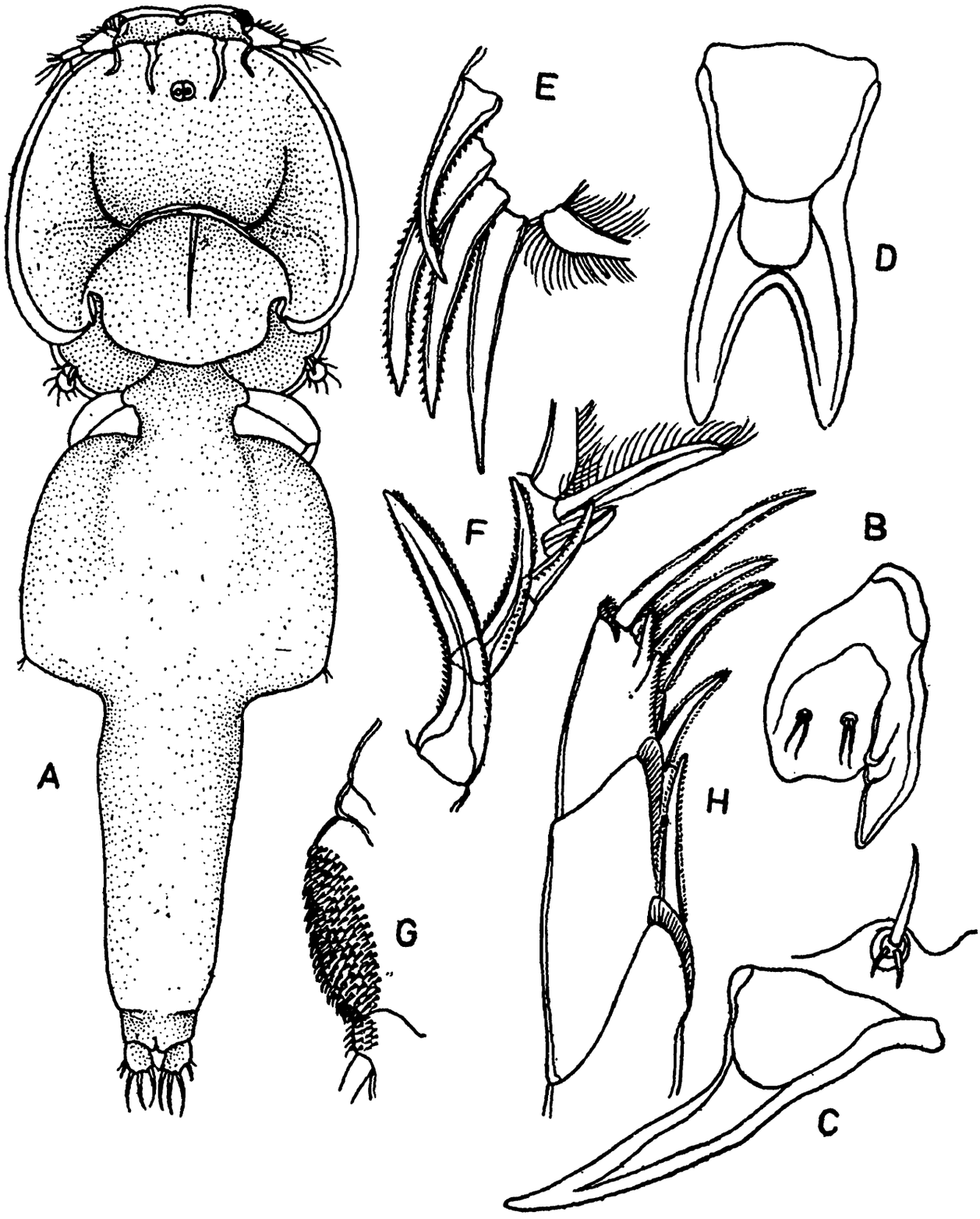


Fig. 87. *Caligus cybii* Bassett-Smith : A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 4.

genital segment, apparently two-segmented, but segmentation indistinct. Caudal rami roughly squarish.

Some of the setae on distal segment of antennule elongated. Basal segment of antenna without process, distal segment slender. Post-antennal process with broad irregular base and short stumpy claw. Post-oral process long, slender and apically acute. Maxilla and maxilliped normal. Sternal fork with roughly squarish base, rami as long as base, narrowing and very slightly diverging.

Basipod of first leg with a patch of denticles, vestigial endopod cylindrical, with small apical lobe carrying a spine, distal exopod segment with the spine-like seta modified into a stout claw similar to the other claws but not dentate. Claws on exopod of second leg very strong and dentate, decreasing in size, first seta small. First segment of endopod externally unarmed, second and third with a patch of sharp spinules. Fourth leg four-segmented, basal segment broad, as long as the rest of the limb, claws winged, at the base of each claw there is a long patch of spinules which at the base of the third and fourth claws forms projecting digitiform pectinate processes.

*Length.*—6.0 mm.

*Male.*—Body like that of female but smaller. Tenital segment comparatively very small and narrowing backwards. Abdomen two-segmented, first segment swollen and narrower than second, forming a waist. Antenna modified, second segment with adhesion pads, third segment strongly curved, with a prominent accessory clay.

*Length.*—4.0 mm.

*Host.—Indocybium lineolatum, Cybium commersoni.*

*Distribution.*—Sri Lanka, India (Bombay, Kerala).

### **Caligus dakari** van Beneden

*Caligus dakari* van Beneden, 1892, p. 243, pl. 5, figs. 1-4 ; Kirtisinghe, 1964 p. 60, figs. 36-37.
*Caligus arii* Barnard, 1955, p. 248, fig. 10 (nec Bassett-Smith, 1898).

*Host.—Arius dussumieri.*

*Distribution.*—South Africa, Sri Lanka.

*Remarks.*—I have no specimen of this species nor could I consult the original description. Therefore the inclusion of this species in the Indian fauna is on the authority of Kirtisinghe.

Barnard observed that in his specimens of *C. arii* the abdomen does not show any trace of a second segment. In *C. arii* the segmentation is not distinct. But there is a distinct constriction indicating a segment. The caudal rami in Barnard's specimens are small but well developed. In *C. arii* they are normally developed but sunk into the abdomen. The fourth leg in Barnard's specimens is three-jointed but in *C. arii* it is four-segmented. Without a chance to study the specimens I am not able to express a definite opinion whether *C. dakari* occurs in Indian waters.

### **Caligus dasyaticus** Rangnekar

(Fig. 88)

*Caligus dasyaticus* Rangnekar, 1957b, p. 16, fig. 1 ; Shiino, 1960a, p. 473, fig. 2 ; Yamaguti, 1963, p. 52 ; Kabata, 1966c, p. 563, fig. 1 ; 1968b, p. 3 ; Pillai., 1967d, p. 1581, fig. 49 ; 1968b, p. 9, fig. 1 ; Margolis *et al.*, 1975, p.28.

*Female.*—Cephalothorax gradually widening backwards. Frontal plates very low. Lunules comparatively small. Postero-median lobe of cephalothorax about one and a half times as broad as lateral lobes, projecting well beyond the latter, distally subtruncate. Posterior sinuses wide open. Fourth thoracic segment very large, more than half the length of genital segment, laterally drawn out into long processes. Genital segment swollen, nearly equal in length and width, partially fused with fourth segment and abdomen. Abdomen about one and a half times as long as genital segment, antero-laterally shoulder-like and narrowing backwards, apparently one-segmented. Caudal rami large, oval, with heavily plumose setae, their surface studded with very fine denticles.

Basal segment of antenna without process, distal segment bent at right anbles in the middle, subapically transversely wrinkled.

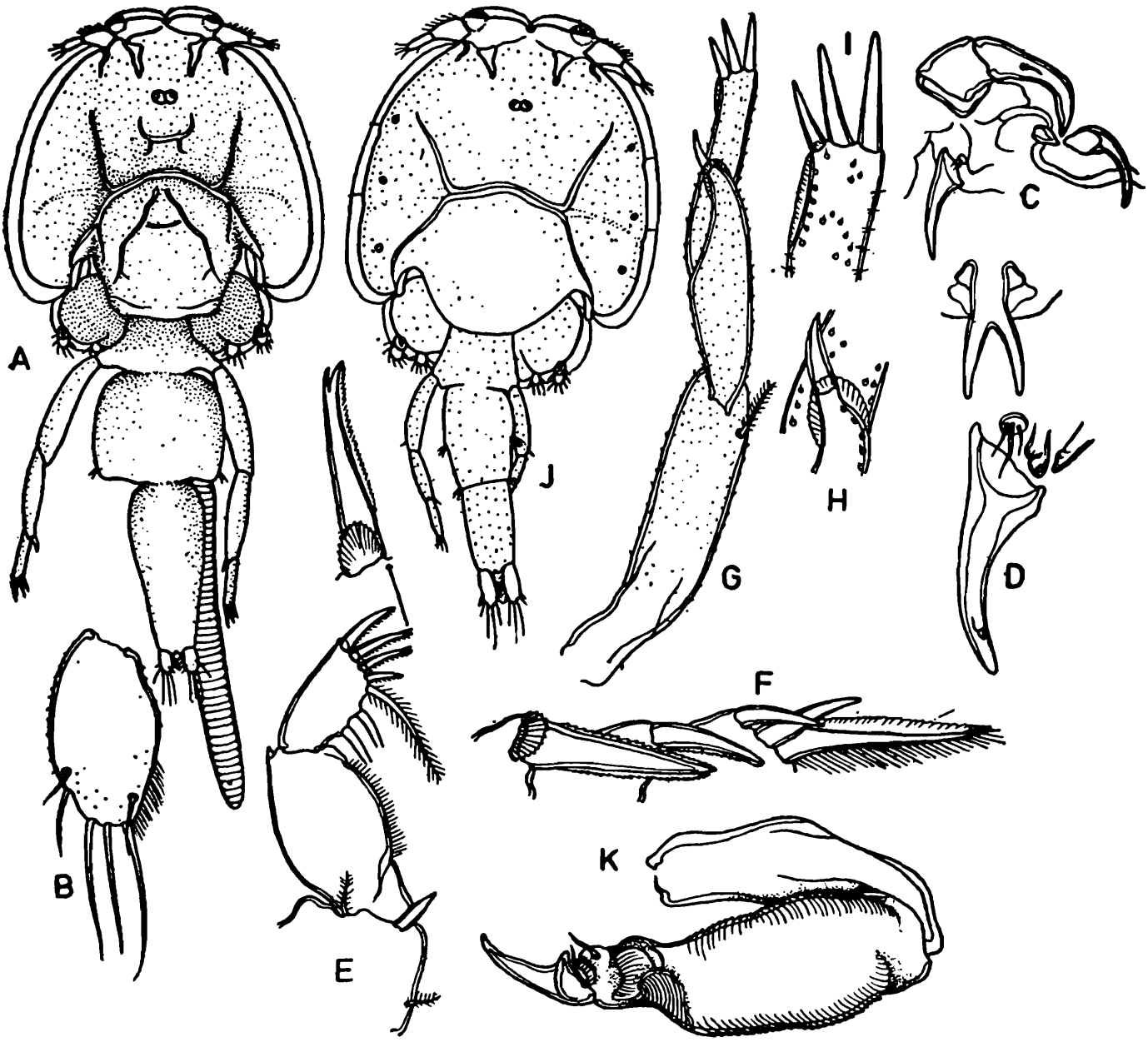


Fig. 88. *Caligus dasyaticus* Rangnekar : A-I, Female. A, female, dorsal view ; B, caudal ramus ; C, antenna, post-antennal process, post-oral process and sternal fork ; D, post-oral process and maxillule ; E, leg 1 ; F, leg 2, exopod ; G, leg 4 ; H, same, tip of segment 2 ; I, same, tip of segment 3. J-K, Male, J, male, dorsal view ; K, antenna.

Post-antennal process long and slender, with small base, claw strongly curved and apically blunt. Post-oral process subequal to post-antennal in size but more strongly narrowing. Maxilliped long and slender, comparatively weak. Sternal fork with short narrow base and long slender diverging limbs.

First leg fairly stout, vestigial endopod clongate conical and prominent, first exopod segment short but broad, second about

two-thirds as long as first, with the customary armature, lower setae very long, spine-like seta very short and pectinate. First two claws on exopod of second leg nearly straight, with narrow serrate flange, third naked. Endopod segments externally hairy. Basal claw of exopod of third leg with stout base, second and third segments fused. Fourth leg three-segmented and curiously twisted, the whole limb covered with small denticles, claws short and winged.

*Length.*—7.0 mm.

*Male.*—Cephalothorax similar to that of female, postero-median lobe distally rounded, lateral lobes comparatively narrow. Fourth segment not produced at the base of the legs. Genital segment narrower than fourth segment. Abdomen one-jointed, as long as genital segment.

First two segments of antenna with adhesion pads, third with a spine-like seta and a stout accessory claw. Post-antennal process stouter than in female. Post-oral process shorter but stouter. Maxilliped stouter, without additional armature. Surface of body and appendages spiny.

*Length.*—3.3 mm.

*Host.*—*Dasyatis uarnak*, *D. akajei*, *Amphotistius kuhlii*, *Pristis* sp.

*Distribution.*—India (Bombay, Kerala), Japan, Queensland.

*Remarks.*—as already observed this species parasitic on elasmobranchs shows extreme chitinisation in the antennae, post-antennal process, post-oral process, maxillipeds and the sternal fork.

## **Caligus diaphanus** von Nordmann
## (Fig. 89)

*Caligus diaphanus* ; Kroyer, 1863, p. 79, pl. 7, fig. 5 ; Thompson and Scott 1903, p. 292 ; Scott, T & A, 1913, p. 60, pl. 17 ; Kirtisinghe, 1964, p. 56, fig. 31.

*Female.*—Cephalothorax slightly broader than long, with small but projecting lunules. Postero-median lobe about one and a half

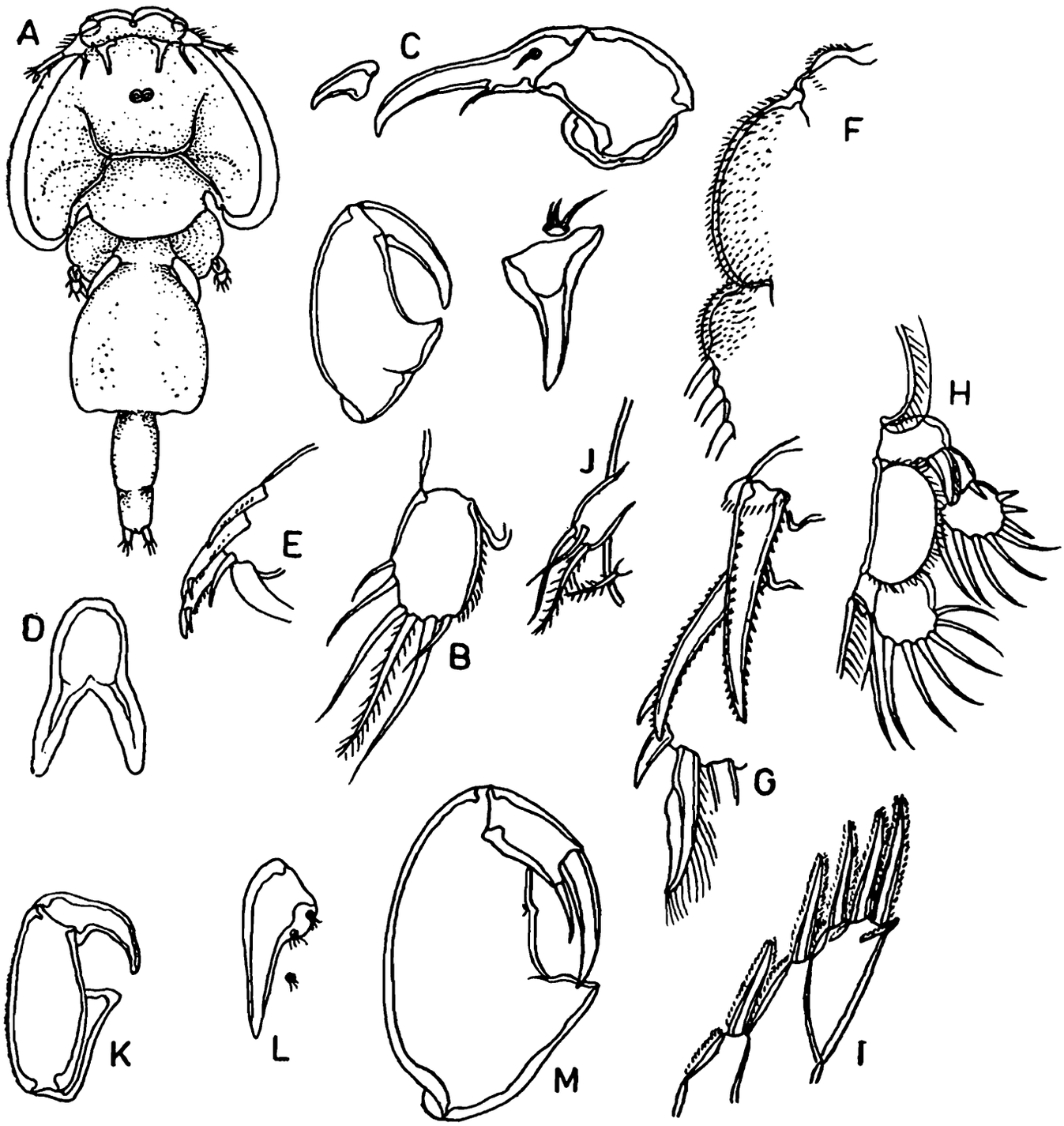


Fig. 89. *Caligus diaphanus* Nordmann : A-J, Female. A, female, dorsal view ; B, caudal ramus ; C, antenna, post-antennal process and post-oral process ; D, sternal fork ; E, leg 1 ; F, leg 2, endopod ; G, same, exopod ; H, leg 3 ; I, leg 4 ; J, legs 5-6 ; K-M, Male. K, antenna : L, post-antennal process ; M, maxilliped.

times as broad as lateral lobes. Posterior sinuses fully open. Fourth segment broader than long. Genital segment inverted U-shaped. Abdomen as long as genital segment, two-segmented, first segment about twice as long as second.

Basal segment of antennule with stout setae. Basal segment of antenna without process, distal steadily narrowing, apically slightly curved. Post-antennal process a small curved claw. Post-oral process elongate triangular. Basal segment of maxilliped produced into a large process, distal segment a strong claw. Base of sternal fork as long as limbs, latter of the same width throughout, apically blunt and diverging.

Distal segment of first leg with three claws reclining against one another and successively increasing in length, second and third with small accessory spine, spine-like seta similar to the claws but small and naked. Basal segment of endopod of second leg with a short row and second and third with large patches of spinules. First two claws on exopod very long, third very short. Basal claw of exopod of third leg externally winged, second segment of endopod externally bulged. Fourth leg rather broad, four-segmented with five prominently winged claws, steadily increasing in length, each claw with a long patch of denticles near its base.

*Male.*—Distal segment of antenna short and claw-like, basally enlarged. Post-antennal process a strong straight process with broad base. Distal segment of maxilliped with a large accessory spine.

*Host.—Autisthes puta, Lates clacarifer, Solea vulgaris, Trigla* sp.

*Distribution.*—Sri Lanka, North Sea, Mauritania.

*Remarks.*—Kirtisinghe recorded this species from Ceylon. It is possible that Thompson and Scott's record influenced his action. As he has given no details further comment is not possible.

Kirtisinghe made *C. multispinosus* described by me a synonym of *C. diaphanus*. To clarify this I examined specimens of *C. diaphanus* collected by Gurney from *Trigla gurnadus* at Plymouth and kept in the British Museum. It is indeed true that these two species show some resemblance. But they differ in the shape of the maxilliped, sternal fork and the fourth leg. In *C. diaphanus* the calws on the fourth leg are all winged while in *C. multispinosus* the first four claws are pectinate all over and the last naked. In *C. multispinosus*

the basal segment of the maxilliped is normal but in *C. diaphanus* there is a large process.

Plate three in Shen's paper refers to *C. multispinosus* and not *C. eleutheronema*. There is a possibility that *C. diaphanas* described by Kirtisinghe is the same as *C. multispinosus* and different from *C. diaphanus* Nordmann. It should be pointed out that *C. diaphanus* is primarily an Atlantic species. Unfortunately I could not get Kirtisinghe's specimens for study and hence this question cannot be definitely answered.

**Caligus distortus** Pillai and Natarajan
(Fig. 90)

*Caligus distortus* Pillai and Natarajan, 1977, p. 33, figs. 67-80.

*Female.*—Cephalothorax comparatively very large, longer than broad, with deep projecting frontal plates, lunules inconspicuous. Postero-median lobe of cephalothorax very broad, postero-lateral angular and curving inwards. Posterior sinuses moderately deep, broad and fully open. Fourth segment small, fused with genital segment. Latter distorted, right side curved and left nearly straight. Abdomen small and one-segmented, originating from the ventral side of the genital segment. Caudal rami small, attached to the ventral side of abdomen, slightly symmetrical, each carrying four long plumose setae and two short setae.

Basal segment of antennule much longer than distal, with pectinate setae. Antenna very long, basal segment with a long process, third segment stout and strongly falcate, with a stout basal process and a slender middle seta. Post-antennal process indistinct. Post-oral process long and slender. Maxilla with short proximal and long distal segment, latter with long apical and short slender subapical spine. Maxilliped very slender, with very short distal segment, basal segment with three proximal inner conical processes. Sternal fork with squarish base and very slightly diverging apically flattened limbs.

Basipod of first leg with large dorsal and small ventral setae, vestigial endopod large, cylindrical, with spiny surface.

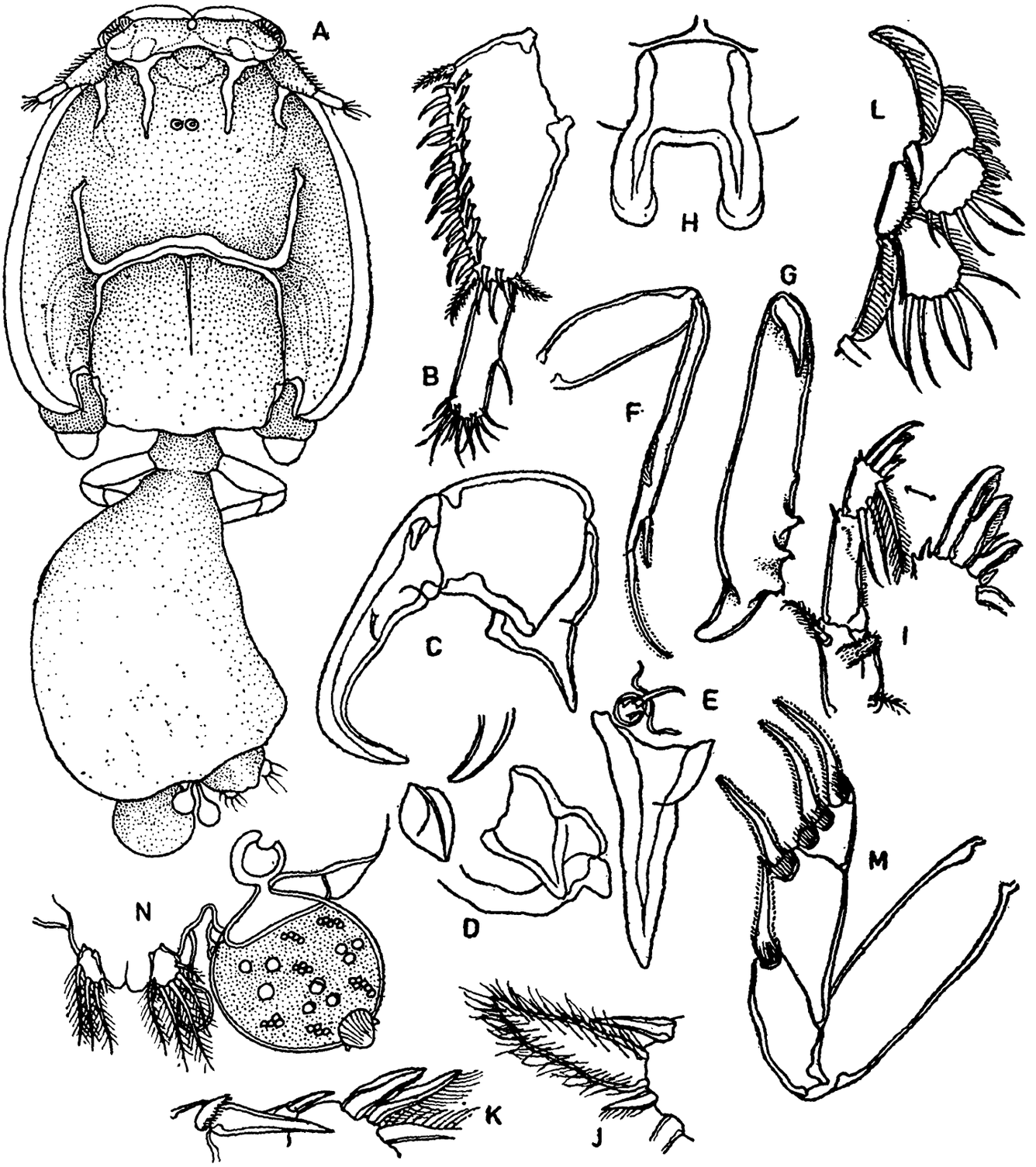


Fig. 90. *Caligus distortus* Pillai and Natarajan : A, fermale, dorsal view ; B, antennule : C, antenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, maxilla ; G, maxilliped ; H, sternal fork ; I, leg I ; J-K, leg 2, exopods ; L, leg 3 : M, leg 4 ; N, abdomen and caudal rami.

Second exopod segment with three stout claws, a small tooth representing the spine-like seta and three long setae with pectinate

outer and plumose inner margin, claws with ventral flange. successively decreasing in length, second and third claws with accessory process. First claw of exopod of second leg large, second small, first two setae modified, on the opposite side the second claw is larger, first seta converted into a stout plumose process, second modified seta is small and sparsely plumose and the third seta naked. Endopod segments externally spiny as in *C. arii.* Basal claw of exopod of third leg very small, exopod highly flattened, second segment of endopod fairly large. Fourth leg rather broad, basal segment as long as rest of limb, second segment with one claw, third with one and fourth with two claws, all the claws long, slender and irregularly curved, with fairly broad wings. Subtending each claw is a bunch of long hairs similar to the bunches on the fourth leg of *Parapetalus hirsutus.*

*Length.*—2.0 mm.

*Host.*—*Tachysurus* sp.

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological collection at Zoological Survey of India, Calcutta. Reg. No. C2125/2.

*Remarks.*—Even if the asymmetry of the post-cephalothoracic part of the body and the second leg is abnormal this species is unique in the shape of the cephalothorax, maxilliped and the fourth legs. The fourth segment of the fourth leg should have three claws but the single specimen I have actually has only two, the first obviously missing. This is one of the smallest known species of *Caligus.*

## **Caligus epinepheli** Yamaguti
(Figs. 91-92)

*Caligus epinepheli* Yamaguti, 1936b, p. 4, pl. 3, figs. 27-39 ; Shiino, 1952, p. 79, figs. 1-2 ; Pillai, 1963f, p. 75, fig. 5 ; 1967d, p. 1590, fig. 69 ; Kirtisinghe, 1964, p. 57, fig. 32 ; Kabata, 1965b, p. 109, fig. 2 ; Margolis *et al.*, 1975, p. 33.
*Caligus cossacki* Rangnekar and Murti, 1959, p. 78, figs. (nec Bassett-Smith, 1898).

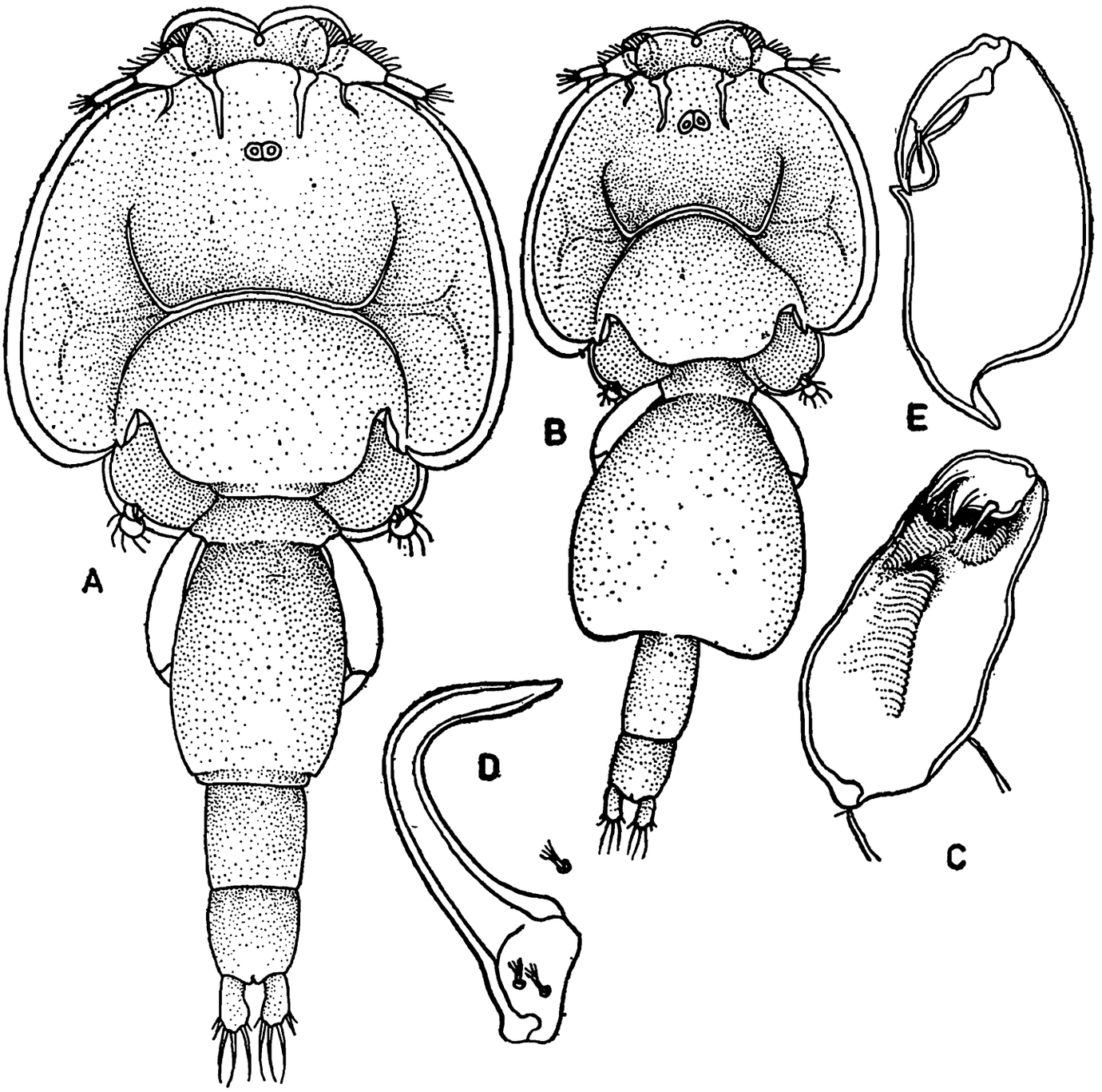


Fig. 91. *Caligus epinepheli* Yamaguti : A, male, dorsal view ; B, female, dorsal view. C-E, Male. C, antenna ; D, post-antennal process ; E, maxilliped.

*Female.*—Cephalothorax widening backwards, frontal plates deep and projecting, lunules fairly large, postero-median lobe twice as broad as lateral lobes and projecting beyond the latter, posterior sinuses wide open. Genital segment fairly large, pear-shaped, postero-lateral parts slightly projecting, Abdomen two-segmented, first segment about twice as long as second. Caudal rami twice as long as broad.

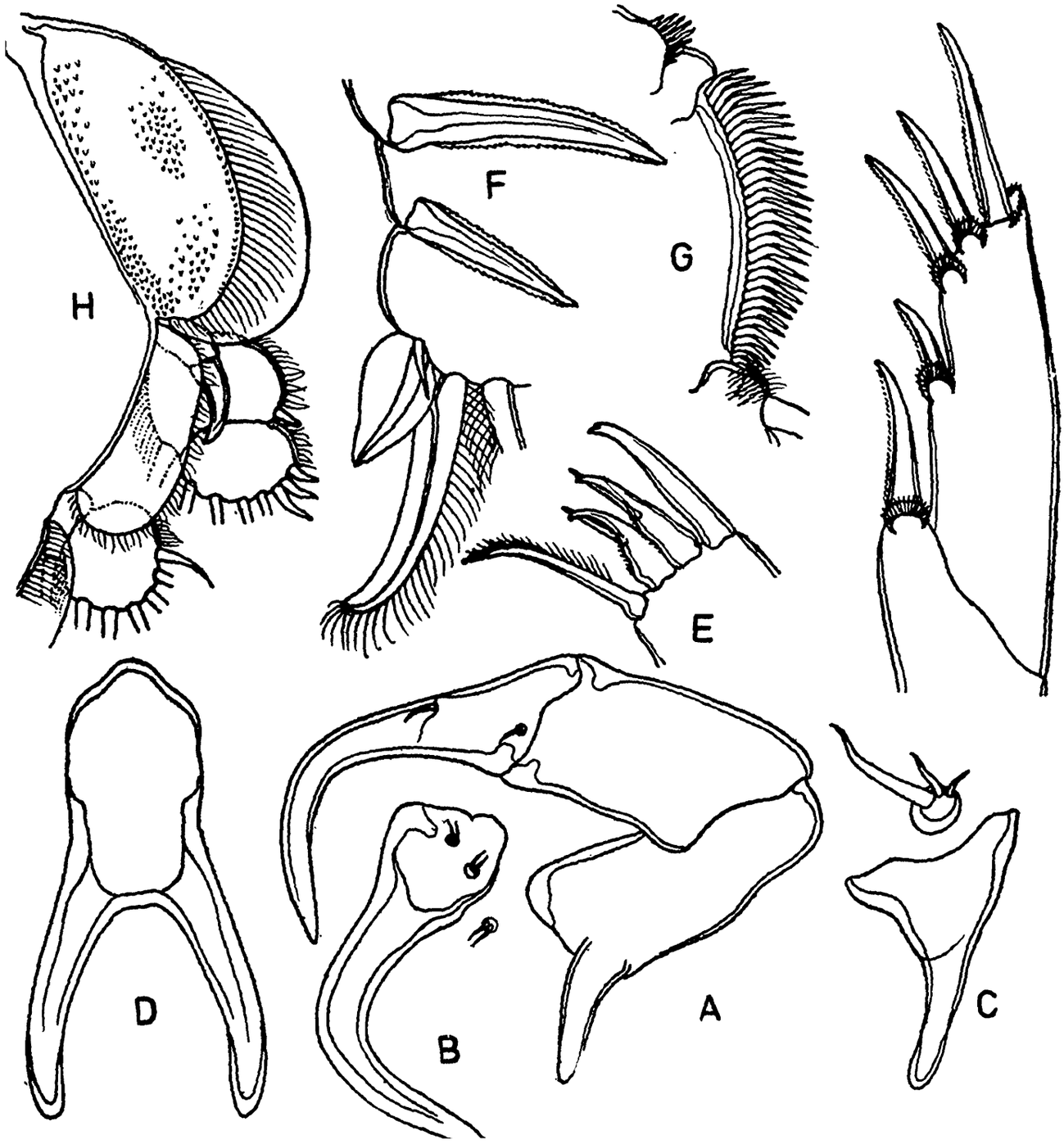


Fig. 92. *Caligus epinepheli* (contd.) : Female. A, natenna ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 3 ; I, leg 4.

Basal segment of antenna with unusually long digitiform process, distal segment strong, moderately stout and bent in the middle. Post-antennal process an elongated claw bent in the middle, base only slightly broader than claw. Post-oral process comparatively

small. Sternal fork with short base and long diverging limbs, apically slightly curving inwards.

Distal segment of first leg without lower setae, spine-like seta longer than the claws, pectinate above, first claw apically bifid, others with prominent accessory process. First two claws on exopod of second leg stout, with serrate flange, first slightly curved, second straight, third small. First segment of endopod with a patch of sharp spines, second with a row of long slender bent spines. Outer part of apron of third leg spiny, basal claw of exopod only moderately curved. Fourth leg three-segmented, claws winhed, second shortest, fifth longest.

*Length.*—4.5 mm.

*Male.*—Postero-median lobe of cephalothorax more rounded and produced than in female. Genital segment oblong, as broad as fourth segment. Abdominal segments subequal in length. Antenna modified, second segment with three adhesion pads, third short and stumpy, apically trifid. Post-antennal process similar to that of female but stouter and more strongly curved. Basal segment of maxilliped produced in the middle of its inner border into a process and another lower but broader process distal to it, second segment closing against the first process.

*Length.*—4.1 mm.

*Host.—Epinepheles septemfasciatus, E. akaara, E. merra, Sparus macrocephalus, Chorinemus tala. C. Iysan, Drepane punctata.*

*Distribution.*—Japan, Sri Lanka, Australia, India (Bombay, Kerala).

### **Caligus euthynnus** Kurian
(Fig. 93)

*Caligus euthynnus* Kurian, 1961, p. 63, figs. 1-15 ; Pillai, 1963b, p. 513, fig 4; 1967d, p. 1574, fig. 29 ; Kirtisinghe, 1964, p. 51 ; Silas and Ummerkutty, 1967, p. 951, fig. 44 ; Margolis *et al.*, 1975, p. 33.
*Caligus alveolaris* Heegaard, 1962, p. 156, figs. 37-44.

*Host.—Euthynnus affinis, Katsuwonus pelamis, Euthynnus alleteratus.*

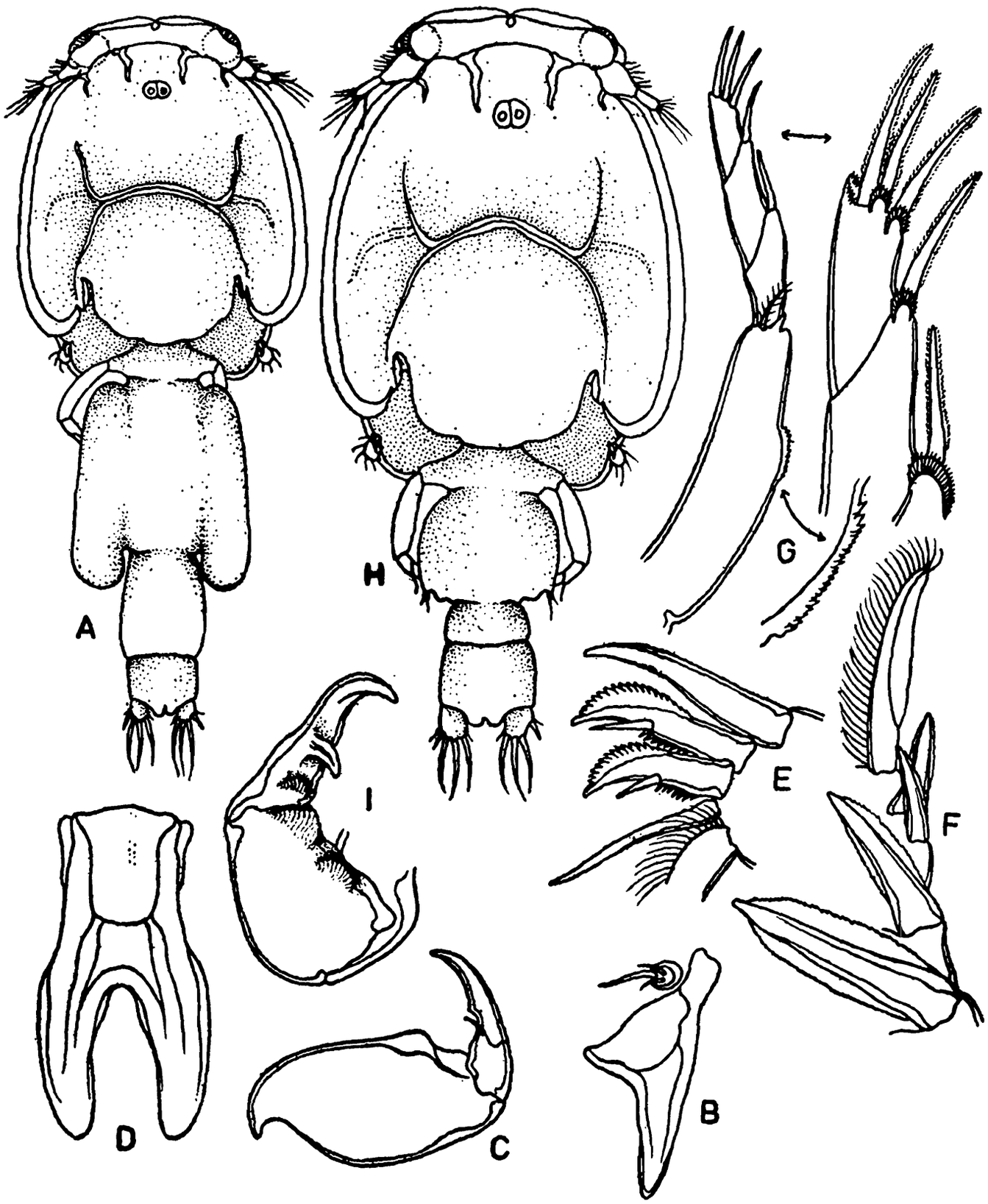


Fig. 93. *Caligus euthynnus* Kurian : A-G, Female. A, female, dorsal view ; B, post-oral process and maxillule ; C, maxilliped ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, leg 4; H, male, dorsal view.

*Distribution.*—India (Kerala), Australia, Sri Lanka.

*Remarks.*—This species very closely resembles *C. coryphaenae* Stp. & Lutk, and parasitises the same host fishes. Kirtisinghe actually considered them synonymous. But a combination of characters distinguishes it from *C. coryphaenae*. It is latter the genital segment is postero-laterally produced into conical lobes but in *C euthynnus* the lobes are perfectly rounded. In *C. coryphaenae* the abdomen is five-segmented but only two-segmented in *C. euthynnus*. More over the first segment is swollen behind in a very characteristic manner. In *C. coryphaenae* the sternal fork has apically acute strongly diverging limbs but in *C. euthynnus* the limbs are parallel and apically rounded. In *C. coryphaenae* the basal claw of the exopod of the third leg is straight or curving outwards but the claw definitely curves inwards in *C. euthynnus*. Above all the apical claw of the fourth leg is much longer than the subapical in *C. coryphaenae* but subequal in *C. euthynnus*. These differences are so constant that this species should be considered as valid.

### **Caligus furcisetifer** Redkar, Rangnekar and Murti (Fig. 94)

*Caligus furcisetifer* Readkar *et al.*, 1949, p. 40, pl. 2, figs. 12-24 ; Yamaguti, 1963, p. 53 ; Pillai, 1967d, p.1592, fig. 77.
*Caligus lepeophtheropsis* Pillai, 1967d, p. 1584, fig. 53 ; 1968b, p. 11, fig. 2 ; Margolis *et al.*, 1975, p. 46.

*Female.*—Cephalothorax comparatively large, frontal plates deep but not projecting, lunules very small, placed at the outer end of the frontal plates. Postero-median lobe of cephalothorax twice as broad as lateral lobes and projecting well beyond the latter, posterior sinuses narrow and fully open. Fourth segment fused with genital segment, latter nearly as long as broad, swollen, both antero-lateral and postero-lateral parts rounded. Abdomen short, one-segmented. Caudal rami longer than broad, sunk into the abdomen.

Basal segment of antenna produced into a strong large conical process. Post-antennal process long, conical, Post-oral process triangular, the chitinous plate in front also produced into a process

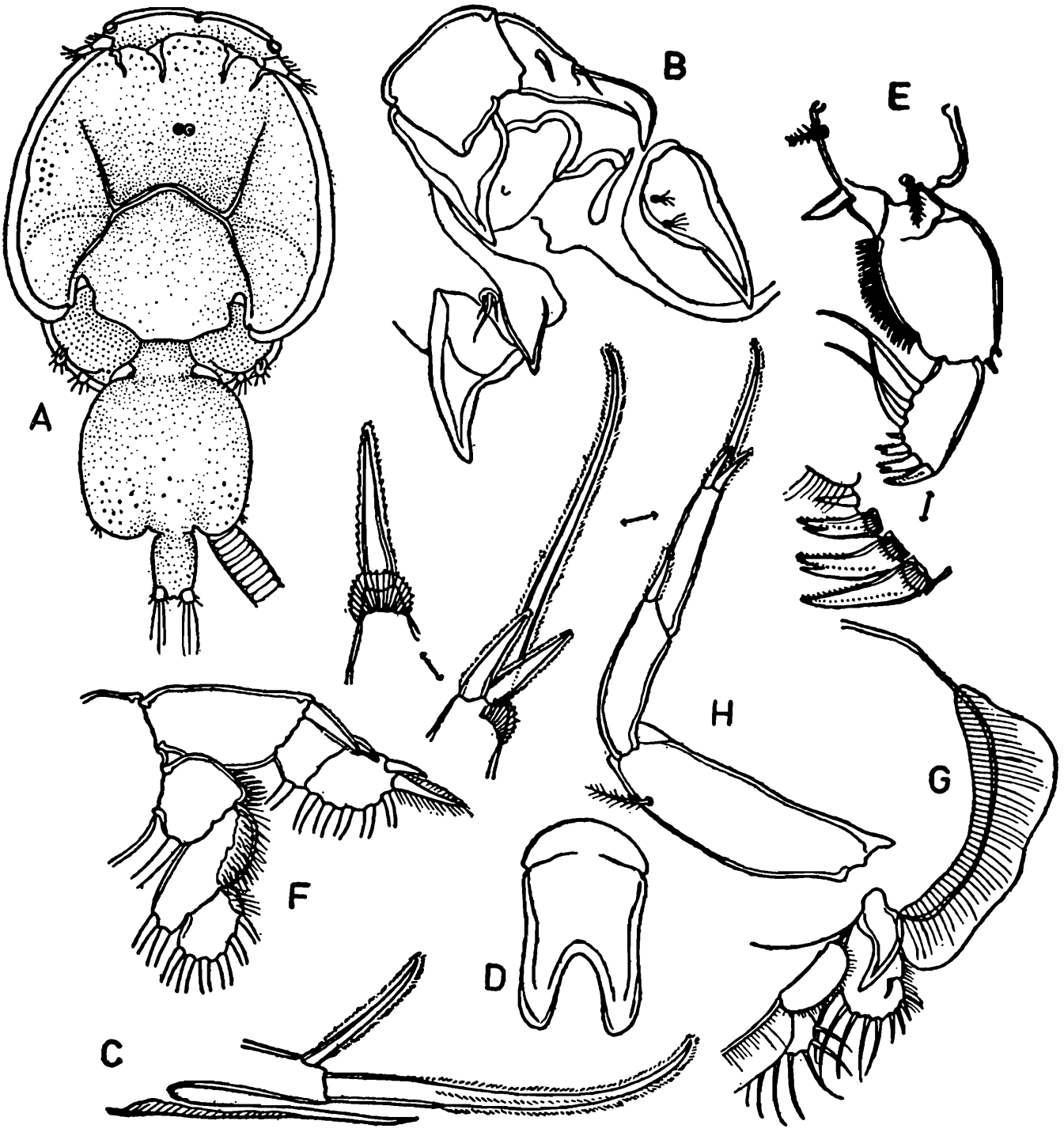


Fig. 94. *Caligus furcisetifer* Redkar et al :A, female, dorsal view ; B, antenna, post-antennal process and post-oral process : C, maxilla ; D, sternal fork ; E-H, legs 1-4.

as in *Pupulina*. Outer flange on distal segment of mixilla prolonged into a process reaching for beyond the segment, apical claw winged and about two and a half times as long as the subapical. Maxilliped weak. Sternal fork with short parallel limbs, apically rounded.

First leg short, vestigial endopod drawn out into a spine, distal exopod segment with three well developed long plumose setae on ventral side, spine-like seta short and naked, claws spiny, second and third with large accessory process making them appear bifid. First two claws of exopod of second leg large, third minute, first seta spine-like, endopod segments with stiff setules. Rami of third leg placed close together. Fourth leg three-jointed, distal segment with only three claws, last claw about four times as long as the others.

*Length.*—5.3 mm.

*Host.*—*Pristis* sp.

*Distribution.*—India (Bombay, Kerala).

*Remarks.*—This species has several unique characters namely the extremely small lunules shifted to the outer ends of the frontal plates, the prolongation of the chitinous plate in front of the post-oral process into a spine, the extreme elognation of the outer flange of the maxilla and the armature of the fourth leg.

The original description of this species failed to reveal every important character and hence I never suspected that my specimen might belong to *C. furcisetifer*. The description by Redkar *et al* contains many errors that comparision is meaningless. Yet the identity of the species is clear.

## **Caligus hamruri** Pillai
(Fig. 95)

*Caligus hamruri* Pillai, 1964b, p. 61, figs. 1-13 ; 1967d, p. 1575, fig. 31 ; Margolis *et al.*, 1975, p. 37.

*Female.*—Cephalothorax large, with deep projecting frontal plates, lunules circular and prominent. Postero-median lobe slightly more than twice as broad as lateral lobes and projecting far beyond the latter, posterior sinuses fully open. Genital segment swollen, broader than long, postero-laterally broadly rounded. Abdomen short, two-segmented. Caudal rami as long as broad.

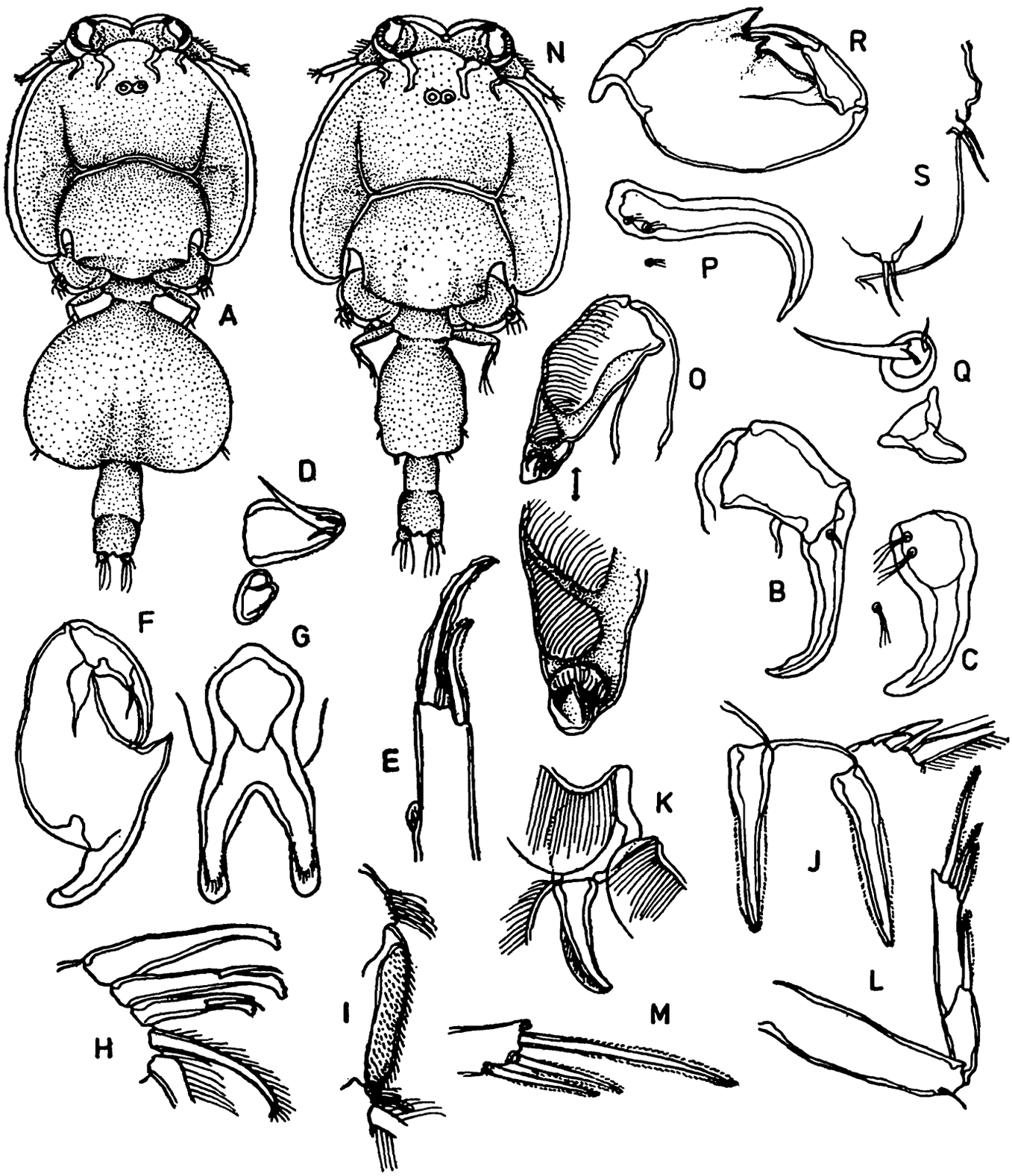


Fig. 95. *Caligus hamruri* Pillai : A-M, Female. A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule; E, maxilla ; F, maxilliped ; G, sternal fork ; H, leg; I, 1, leg 2, endopod ; J, same, expod ; K, leg 3, basal process of exopod ; L, leg 4 ; M, same, tip enlarged. N-S, Male. N, male, dorsal view ; O, antenna ; P, post-antennal process ; Q, post-oral process and maxillule ; R, maxilliped ; S, legs 5-6.

Basal segment of antenna indistinct, third segment only moderately curved. Post-antennal process an elongated claw. Post-oral process very small, triangular. Maxillule large, one of the setae stout. Distal claws of maxilla strong, with broad pectinate wings. Basal segment of maxilliped with prominent inner process, distal short and slender. Limbs of sternal fork diverging and distally flattened.

Basipod of first leg spiny, vestigial endopod with a spinule, distal exopod segment with long apically blunt and lobed claws, accessory process large, spine-like seta externally hirsute, ventral setae short, First two claws of exopod of second leg large, winged and bent downwards, third small, basal segment of endopod hairy, second with a patch of denticles, third hairy. Fourth leg slender three-jointed, with four weak winged claws.

*Length.*—2.5 mm.

*Male.*—Cephalothorax as in female, frontal plates and lunules more prominent. Genital segment roughly rectangular, second segment of abdomen broader than first. Antenna with the customary modifications. Post-antennal process a strongly curved slender claw. Post-oral process larger. Maxilliped with a small process ahead of the large process.

*Length.*—2.2 mm.

*Host.*—*Priacanthus hamrur.*

*Distribution.*—India (Kerala).

*Holotype.*—Female and *Allotype* male in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2126/2 C2127/2.

**Caligus holocentri** sp. nov.
(Fig. 96)

*Famale.*—Cephalothorax somewhat semicircular, frontal plates moderately developed and projecting, lunules large, as deep as frontal plates. Postero-median lobe about four times as broad as

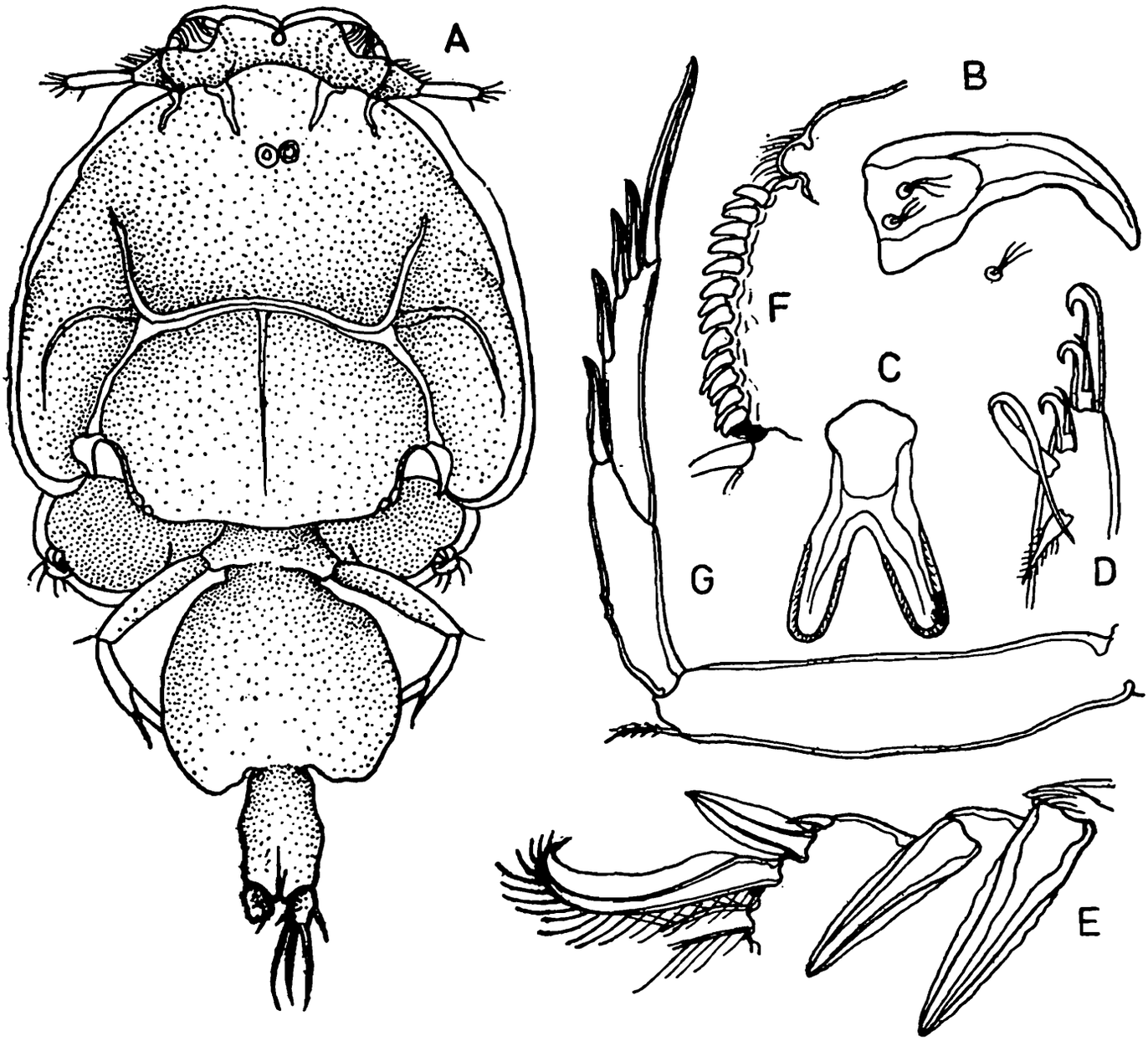


Fig. 96. *Caligus holocentri* sp. nov. : A, female, dorsal view ; B, post-antennal process ; C, sternal fork ; D, leg 1 ; E, leg 2, exopod ; F, same, endopod ; G, leg 4.

lateral lobes, posterior sinuses shallow and wide open. Fourth thoracic segment broader than long, partially fused with genital segment, latter circular, with very short anterior neck, postero-lateral parts forming small but distinct lobes. Abdomen one-joined. Caudal rami with long setae.

Antennule and antenna normal. Post-antennal process stout, distally curved. Maxillule, maxilla and maxilliped normal. Sternal

fork with narrow base, limbs as long as base, diverging, with narrow flange, apices rounded.

Distal segment of first leg with three comparatively small setae, spine-like seta very long, naked, claws without spines, second and third with accessory process. First two claws of exopod of second leg with narrow smooth wings, third claw very small. Basal segment of endopod hairy, second segment with two rows of strong blunt teeth. Fourth leg slender, three-jointed, basal segment as long as rest of limb, claws slender and weak, distal claw twice as long as the penultimate.

*Length.*—2.6 mm.

*Host.*—*Holocentrus rubrum.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Z.S.I. Calcutta. Reg. No. C2128/2.

*Remarks.*—The large postero-median lobe, the sternal fork, the armature of the endopod of the second leg and the nature of the fourth leg distinguish this species.

## **Caligus indicus** Pillai

(Fig. 97)

*Caligus indicus Pillai*, 1961, p. 102, fig. 9 ; 1963f, p. 87 ; 1967d, p. 1578, fig. 39 ; Silas and Ummerkutty, 1967, p. 963 ; Margolis *et al.*, 1975, p. 39.

*Female.*—Cephalothorax nearly circular, frontal plates deep and projecting, lunules large. Postero-median lobe twice as broad as lateral lobes and slightly projecting beyond the latter. Genital segment roughly oblong, gradually widening, antero-lateral and postero-lateral parts rounded. Abdomen short, two-segmented. Caudal rami large.

Antennule short but stout. Antenna with rounded basal process. Post-antennal process stout and sickle-shaped. Post-oral process

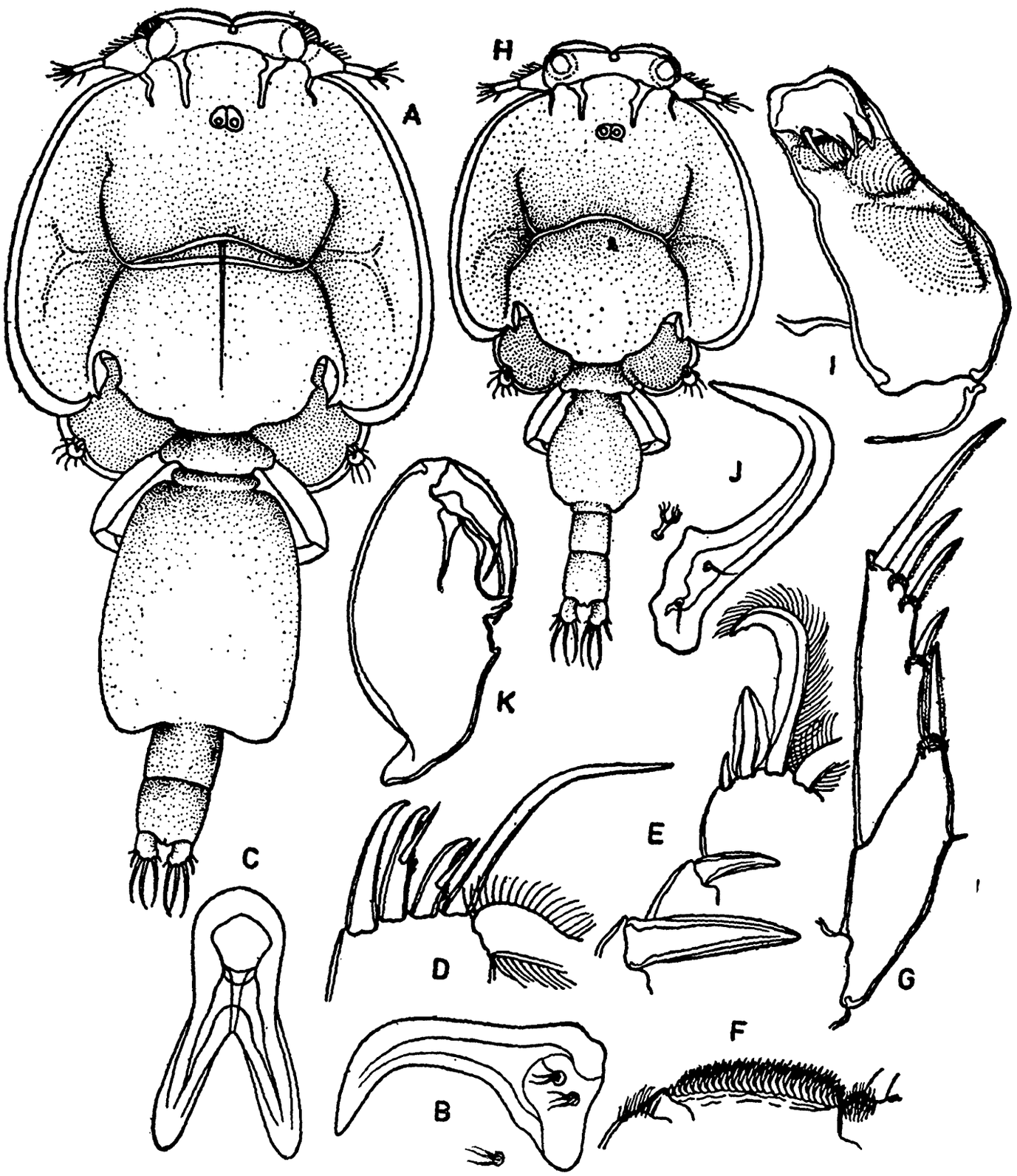


Fig. 97. *Caligus indicus Pillai* : A-G, Female. A, female, dorsal view ; B, post-antennal process ; C, sternal fork ; D, leg 1 ; E, leg 2, exopod ; F, same, endopod ; G, leg 4, H-K, Male. H, male, dorsal view ; I, antenna ; J, post-antennal process ; K, maxilliped.

curved. Basal segment of maxilliped slender and unarmed. Sternal fork with base as long as limbs, latter distally flattened and apically rounded, strongly diverging.

Basipod of first leg spiny, distal segment well armed, first claw unarmed, second and third ventrally spiny and with long accessory process, spine-like seta very long, naked, ventral setae normal. First two claws of exopod of second leg stout, with smooth flange, third claw small, without flange. Second segment of endopod with long sharp spines. Fourth leg three-jointed, basal segment longer than rest of limb, second segment wity a spinule of ventral border, third segment narrowing, giving the limb a very characteristic shape, last claw on third segment twice as long as the penultimate.

*Length.*—6.3 mm.

*Male.*—Cephalothorax as in female, genital segment with anterior neck, beyond the neck circular. Abdomen two-jointed, second segment longer and broader than first. Post-antennal process narrower but longer than in female, more strongly curved. Antenna very stout, second segment with three adhesion pads, third segment short, flat and trifid, with long spine-like seta. Maxilliped stout, basal segment armed with two projections, a bifid strong tooth and a conical projection.

*Length.*—2.2 mm.

*Host.—Trachynotus blochi.*

*Distribution.*—India (Kerala).

*Holotype* and *Allotype* male in the National Zoological Collection at Zoological Servey of India, Calcutta. Reg.No.C2129/2 C2130/2.

*Remarks.*—Kirtisinghe (1964) made *C. indicus* a synonym of *C. cossacki* has not so far been satisfactorily described. The best description is that by Heegaard (1943b). Compared to this *C. indicus* differs in the comparative size of the cephalothorax, shape

of the abdomen, the sternal fork, the armature of the distal segment of the first leg and the structure of the fourth leg. In practically very character *C. indicus* differs from *C. cossacki.*

## **Caligus infestans** Heller
(Fig. 98)

*Caligus infestans* Heller, 1868, p. 167, pl. 14, figs. 3-4 ; Bassett-Smith, 1898c. p. 360 ; Wilson, 1905a, p. 557 ; Nunes Ruivo and Fourmanoir, 1956, p. 69, fig. 1 ; Yamaguti, 1963, p. 54, pl. 61, fig. 4 ; Kirtisinghe, 1964, p. 52, figs, 22-24 ; Kabata, 1965b, p. 109, fig. 2 ; Pillai, 1969, p. 158, figs. 48-62 ; Margolis *et al*, 1975, p. 39.

*Caligus sphyrdeni* Nunes Ruivo and Fourmanoir, 1956, p. 71, figs. 2-3 (nec Pillai, 1961).

*Caligus maculatus* Heegaard, 1962, p. 157, figs. 45-53.

*Female.*—Cephalothorax small, with projecting frontal plates and moderately large lunules. Postero-median lobe about four times as broad as lateral lobes and considerably projecting beyond the latter. Fourth segment large. Tenital segment swollen, postero-laterally produced into large conical lobes reaching the distal border of the first abdominal segment. Abdomen two-segmented, second segment very short. Caudal rami small, squarish, externally spiny, with three long apical setae, a short spine-like outer seta and a small inner seta.

Basal segment of antenna with well developed process, istal segment strongly curved. Post-antennal process stout and strongly curved, with an accessory process inner to it. Post-oral process stout, elongate-triangular and curved. Maxilliped normal. Sternal fork with diverging distally incurving limbs.

Claws on distal segment of first leg short, second and third with accessory process, spine-like seta long. First two claws on exopod of second leg large, winged, bent downwards and forwards, third claw small, slender and naked. Endopod segments with two to three irregular rows small spines. Basal claw of exopod of third leg strongly curved, apron prominently spiny. Fourth leg with very long basal segment, second segment internally bulging, third

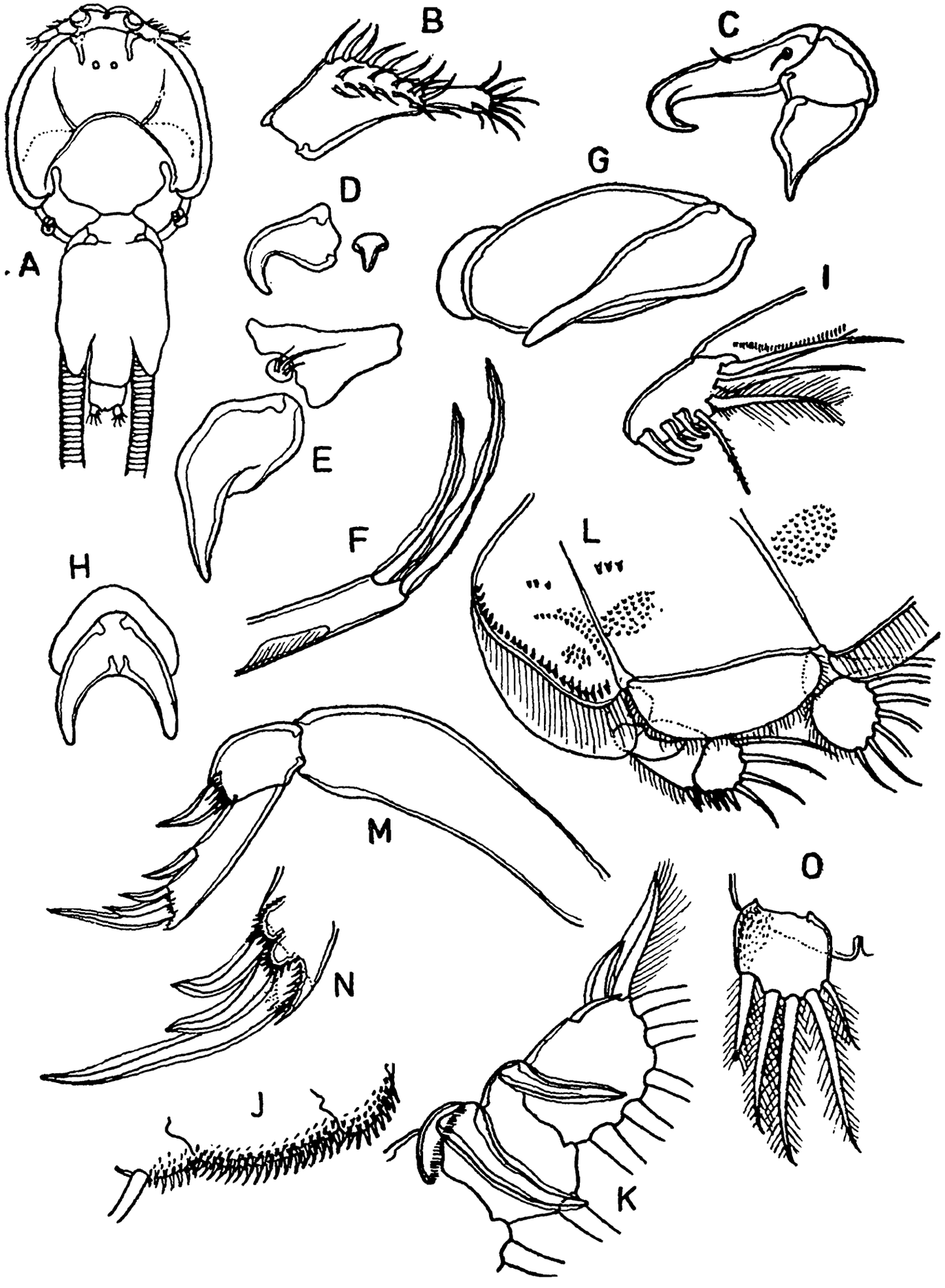


Fig. 98. *Caligus infestans* Heller : A, female, dorsal view ; B, antennule ; C, antenna ; D, post-anntennal process ; E, post-oral process and maxillule ; F, maxilla ; G, maxilliped ; H, sternal fork ; I, leg 1 ; J, leg 2, endopod ; K, same, exopod ; L, leg 3 ; M, leg 4 ; N, same, tip enlarged ; O, caudal ramus.

with four claws, last claw twice as long as the penultimate, the arc of spinules usually seen at the base of the claws converted into large spiny crests.

*Length.*—7.0 mm.

*Host.*—*Cybium commersoni, C. sphyrenae, C. maculatum, Euthynnus alleteretus, Scomberomorus commersoni.*

*Distribution.*—Java, Aden, Madagascar, Sri Lanka, Queensland.

*Remarks.*—The above description is based on a female in the British Museum. The shape of the genital segment, sternal fork and the fourth leg distinguish this species. The figures accompanying this description are unsatisfactory since I had to draw them in situ.

## **Caligus kanagurta** Pillai
(Fig. 99)

*Caligus kanagurta* Pillai, 1961, p. 100, fig. 8 ; 1967d, p. 1581, fig. 46 ; Silas and Ummerkutty, 1967, p. 957, fig. 40 ; Margolis *et al.*, 1975, p. 41.

*Caligus pelamydis* Lewis, 1967, p. 138, fig. 52 (nec Kroyer 1838).

*Parapetalus* sp. Silas and Ummerkutty, 1967, p. 908, fig. 18.

*Female.*—Cephalothorax gradually widening backwards, with moderately broad membranous flange. Frontal plates only slightly projecting, lunules small. Postero-median lobe about twice as broad as lateral lobes, rounded and reaching far beyond the latter, posterior sinuses deep, fully open. Genital segment reinform, as broad as cephalothorax, with short anterior neck, postero-laterally expanded into rounded lobes. Abdomen two-jointed, first segment as long as cephalothorax, swollen and long elliptic. Caudal rami oblong, with six setae.

Basal segment of antennule with highly plumose setae, distal segment with some of the setae elongated. Basal segment of antenna fused with cephalothorax. Post-antennal process reduced to a plate,

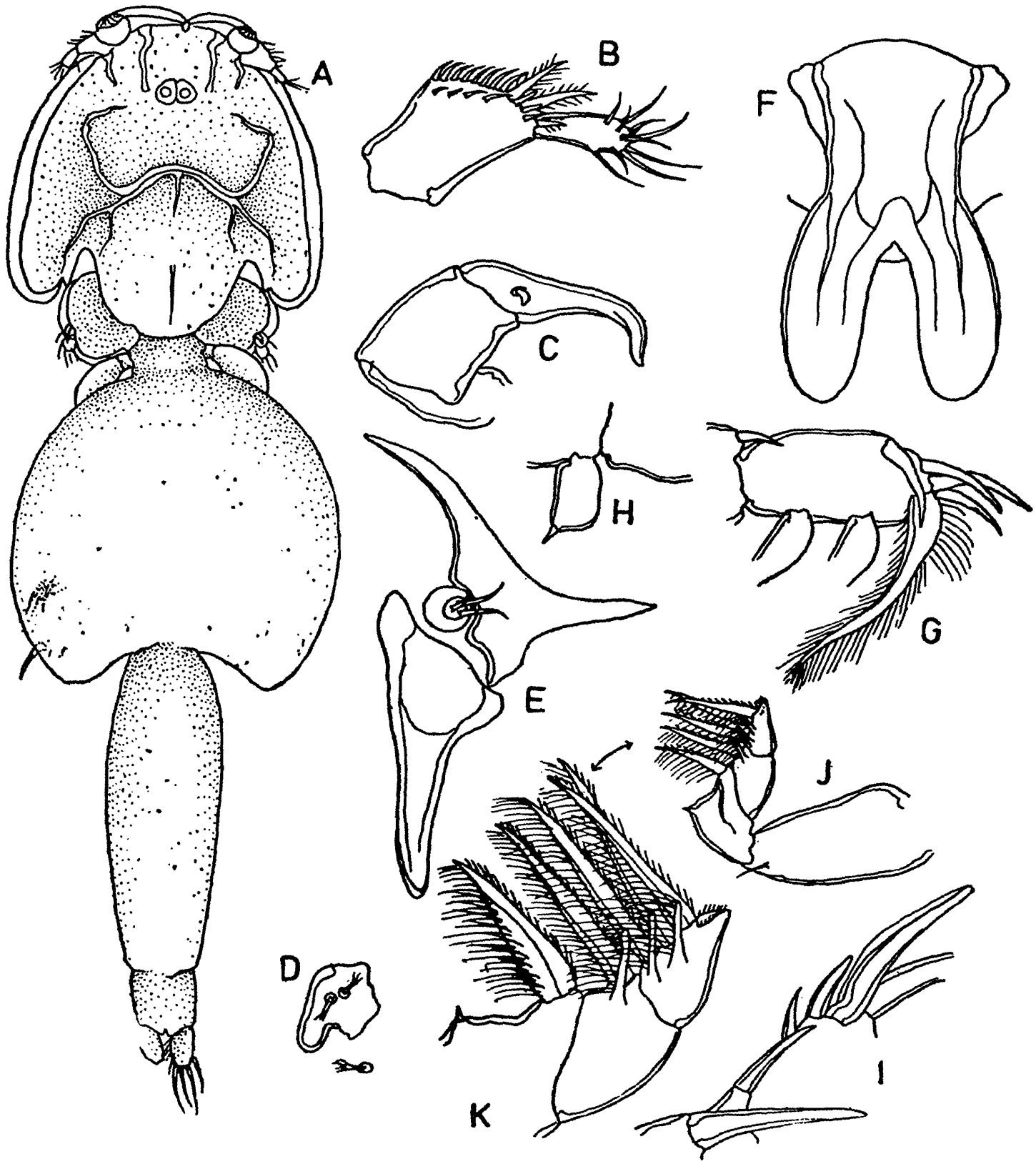


Fig. 99. *Caligus kcnagurta* Pillai ; A, female, dorsal view ; B, antennule ; C, antenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, sternal fork ; G, leg 1 ; H, same, vestigial endopod ; I, leg 2, exopod ; J, leg 4 ; K, same, tip enlarged.

Post-oral process triangular, distally flanged. Sternal fork with rectangular base, limbs diverging, with broad outer flange.

Distal segment of first leg with well developed setae and four subsimilar smooth claws, spine-like seta claw-like. First two claws on exopod of second leg long, third short, second and third segments of endopod with large outer patch of denticles. Rami of third leg placed wide apart, basal claw of exopod short, winged, curving inwards. Fourth leg four-segmented, second segment irregular, claws hirsute and successively increasing in length. The crest of spinules at the base of the claws form long digitiform processes carrying a row of long hairs at the base of claws two to four.

*Length.*—4.2 mm.

*Host.*—*Rastrelliger kanagurta.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta, Reg. No. C2131/2.

*Remarks.*—Lewis suggested that *C. kanagurta* is very close to *C. pelamydis* but differs in the presence of three setiferous processes on the fourth leg against one in *C. pelamydis.* I examined specimens of *C. pelamydis* identified by Scott and Scott (1913) and kept in the British Museum. The fourth leg in this species actually has three processes and it might be that Lewis failed to locate all of them. A careful comparison of published descriptions shows that two types of specimens are involved. In the typical *C. pelamydis* the genital segment is narrower than the cephalothorax with its postero-lateral parts not produced (Wilson, 1905a, Hewitt, 1963). In *C. kanagurta* this segment is even broader than the cephalothorax with its postero-lateral parts produced. Collections of *C. pelamydis* with large genital segment may be transferred to *C. kanagurta* and the others retained in *C. pelamydis.*

### **Caligus lagocephali** Pillai

(Fig. 100)

*Caligus lagocephali* Pillai, 1961, p. 107, fig. 12 ; 1967d, p. 1576, fig. 34 ; Margolis *et al.*, 1975, p. 45.

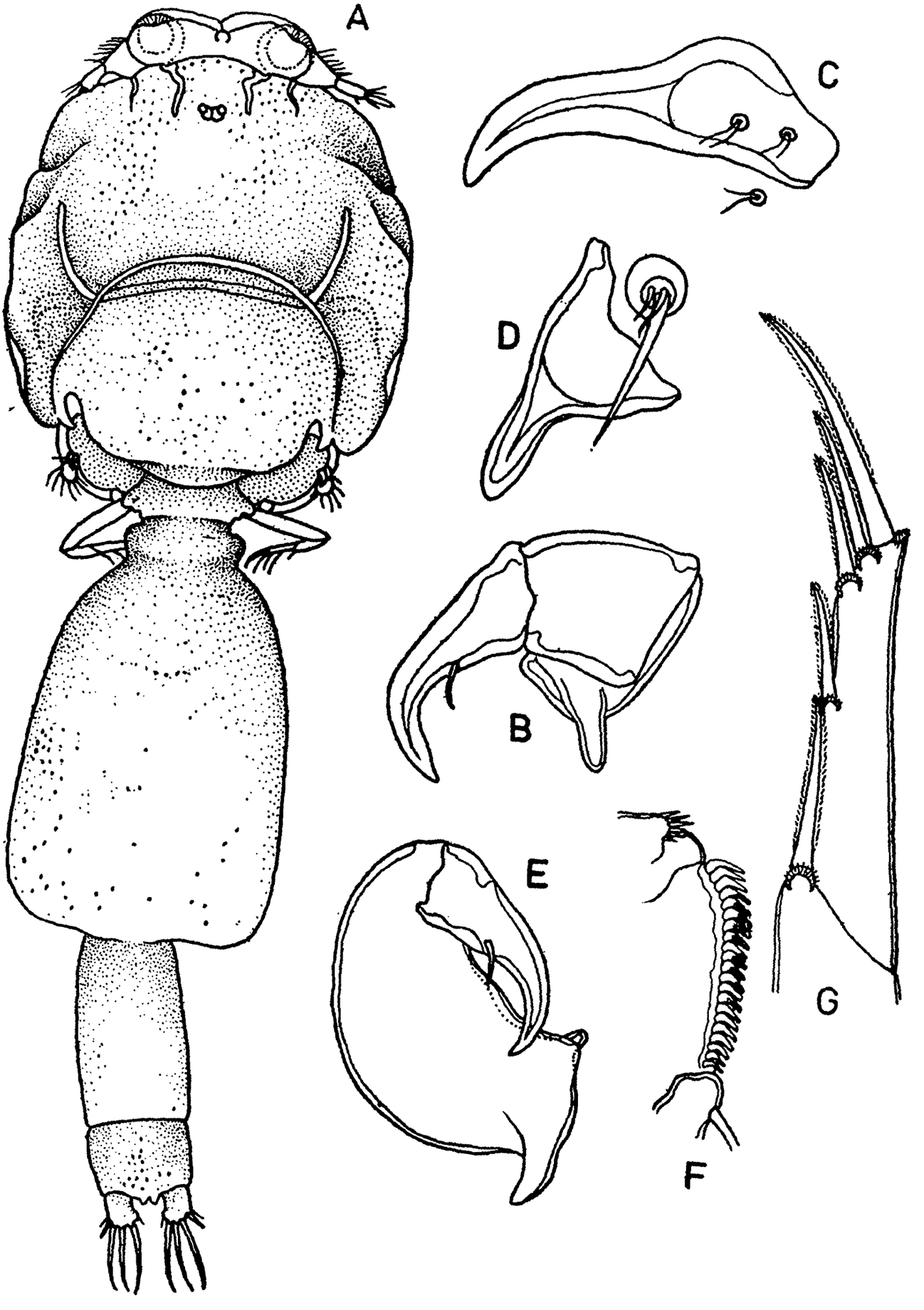


Fig. 100. *Caligus lagocephali* Pillai : A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilliped ; F, leg 2, endopod ; G, leg 4.

*Female.*—Cephalothorax nearly circular but appears elongated due to the folding of the lateral parts downwards. Frontal plates deep but not much projecting, lunules as deep as frontal plates. Postero-median lobe of cephalothorax very broad, about six times as broad as lateral lobes. Fourth thoracic segment very broad, forming lobes at the base of the legs. Genital segment like a short-necked jar, broadening backwards. Abdomen two-segmented, first segment more than twice as long as second.

Antennule short but stout. Antenna large, basal segment with an unusually large process. Post-antennal process stout, slightly curved, post-oral process distally flattened and apically rounded. One of the setae of maxillule large. Claws of maxilla short but stout, with broad wings. Maxilliped stout, basal segment with a large blunt tooth-like process, distal segment well curved. Sternal fork with parallel, distally narrowed limbs.

First leg small, distal segment without ventral setae, spine-like seta moderately long and naked, second and third claws with large accessory process. First two claws of exopod of second leg with broad serrate wings, third small and barbed. Basal segment of endopod with a row of sharp spines, second segment with four rows of short overlapping teeth (not in the figure). Fourth leg three-segmented, distal claw of third segment twice as long as the penultimate.

*Length.*—2.8 mm.

*Host.—Lagocephalus inermis.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2132/2.

*Remarks.*—The curious folding of the lateral parts of the cephalothorax may be an artefact. But this species shows several diagnostic characters apart from that of the cephalothorax.

## **Caligus laticaudus** Shiino

(Fig. 101)

*Caligus laticaudus* Shiino, 1960a, p. 482, figs. 5-6 ; Pillai, 1961, p. 91, fig. 3 ; 1967d, p. 1579, fig. 40 ; Yamaguti, 1963, p. 55, pl. 68, fig. 4 ; Lewis, 1968, p. 71, figs. 29-30 ; Margolis *et al.*, 1975, p. 45.

*Female.*—Cephalothorax elegantly rounded, frontal plates low, lunules small and inconspicuous. Postero-median lobe one and a half times as broad as lateral lobes and very slightly projecting, posterior sinuses broad and fully open. Fourth thoracic segment roughly triangular, broader than long. Genital segment large, swollen and hermispherical. Abdomen short, two-segmented, first segment swollen.

Antenna without process on basal segment. Post-antennal process elongate-triangular and slightly curved. Post-oral process apically curved and blunt. Maxilliped stout, with large process on basal segment, distal segment stout. Sternal fork with limbs as long as base, broad and flattened, apically rounded and slightly diverging.

Vestigial endopod of first leg flattened and drawn out into a spine, distal segment of exopod with large ventral setae, distal border oblique, spine-like seta similar to the claws and forming a series, none of them armed. First two-claws of exopod of second leg large and barbed, third small and naked, first seta a digitiform process, second without wing, segments of endopod armed with spinules, first with a row and others with a broad patch. Fourth leg four-jointed, claws long and winged, spiny crest at the base of the claws long.

*Length.*—2.6 mm.

*Male.*—Genital segment small, oval. Abdomen two-segmented, first segment very small. Antenna with an adhesion pad at inner distal part of second segment, distal segment with prominent accessory claw, otherwise as in female. Maxilliped with the process on basal segment trifid, otherwise similar to that of female.

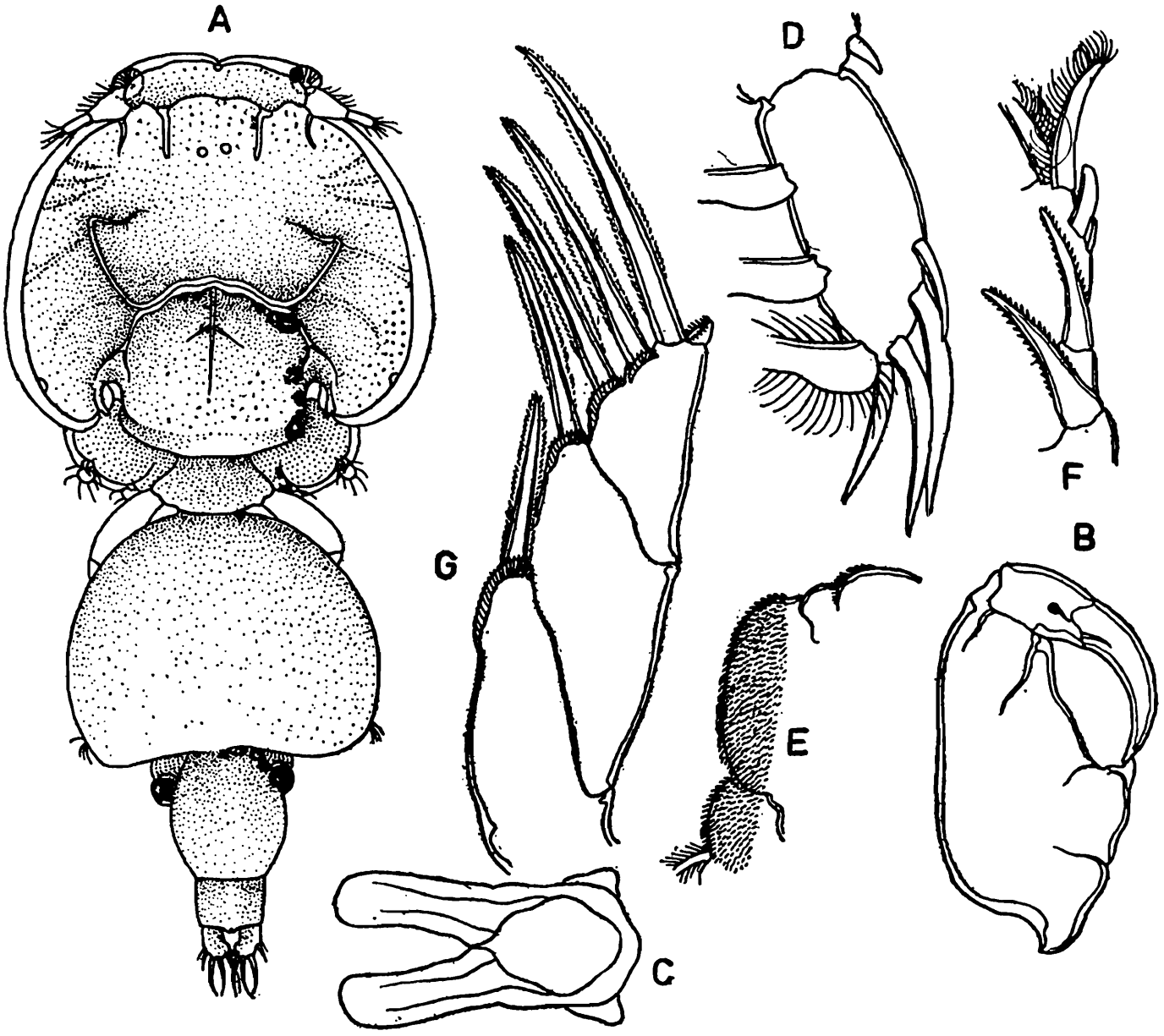


Fig. 101. *Caligus laticaudus* Shiino : A, female, dorsal view ; B, maxilliped ; C, sternal fork ; D, leg 1 ; E, leg 2, endopod ; F, same, exopod ; G, leg 4.

*Host.—Pagrosomus major, Polynemus heptadacylus, Rhabdasargus sarba, Acanthopagurus olivaceus.*

*Distribution.*—Japan, India (Kerala), Marshall Islands.

## Caligus lobodes (Wilson)

(Fig. 102)

*Midias lobodes* Wilson, 1911b, p. 626, pl. 25 ; Shiino, 1958b, p. 98, figs. 1-3 ; Yamaguti, 1963, p. 107, pl. 127, fig. 1 ; Kirtisinghe, 1964, p. 71, fig. 76 ; Lewis, 1967, p. 94, figs. 34-36.

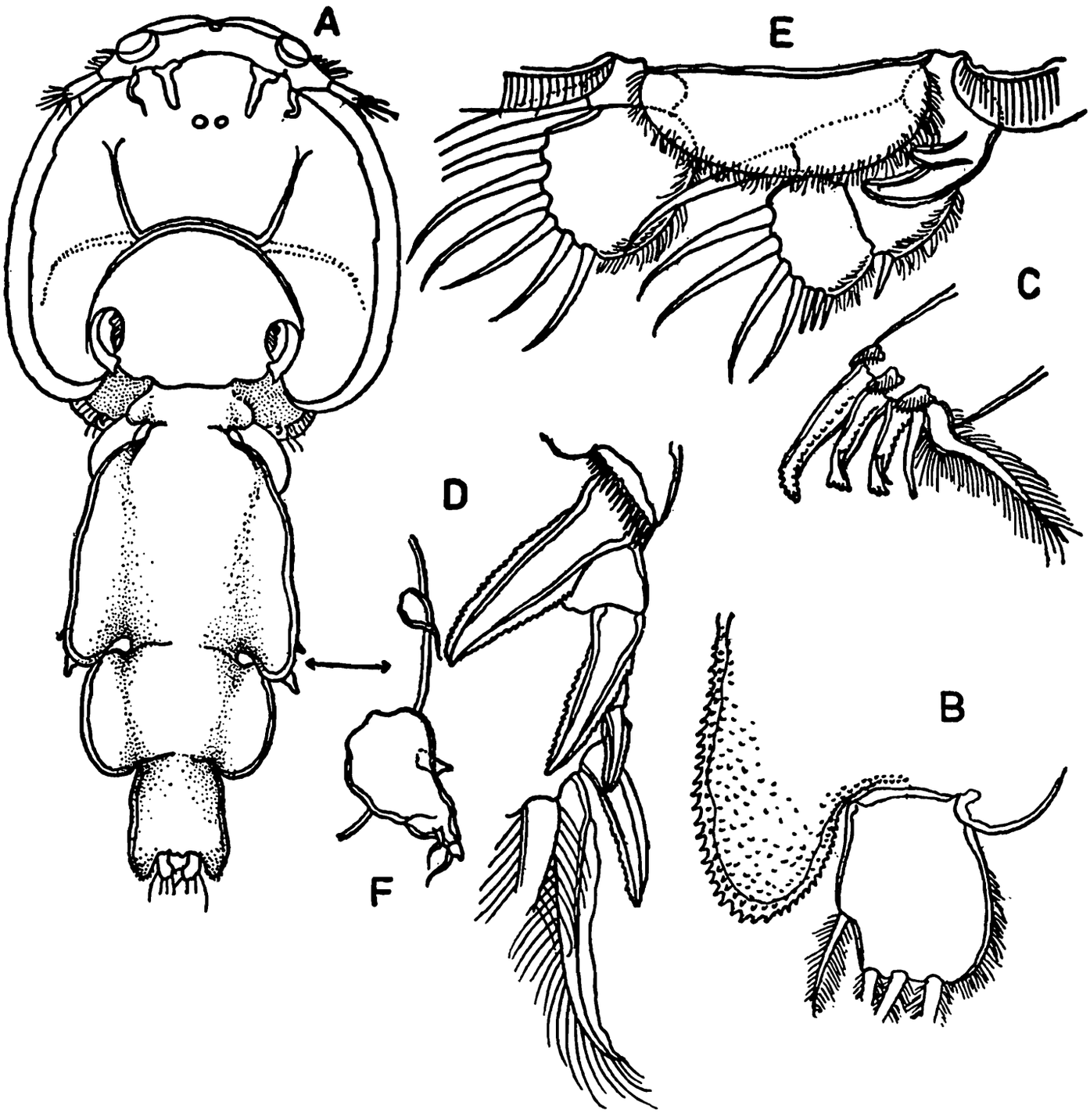


Fig. 102. *Caligus lobodes* (Wilson) : A, female, dorsal view ; B, caudal ramus ; C, leg 1 ; D, leg 2, exopod ; E, leg 3 ; F, legs 5-6.

*Female.*—Cephalothorax as long as broad, frontal plates moderately deep, postero-median lobe twice as broad as lateral lobes, with nearly transverse hind border. Lateral lobes curving inwards, contacting the median lobe and closing the posterior sinuses. Fourth thoracic segment broader than long, produced at the base of the legs. Genital segment enlarged, nearly equal in

length and width, not clearly separated from adjacent segments. Abdomen two-segmented, first segment only slightly longer than second and expanded into longitudinally oblong lateral lobes, second segment nearly equal in length and width, with parallel sides, distal corners prolonged into rounded lobes with spiny surface.

Basal process of antenna small and blunt, distal segment distally recurved. Post-antennal process a small claw, post-oral triangular with accessory process. Strenal fork with diverging apically incurving limbs.

Vestigial endopod of first leg with two short apical spines, distal segment with the claws apically blunt and cut into lobes, second and third claws with small accessory process. Spine-like seta as long as third claw. Basal segment of endopod of second leg with its proximal half hairy, distal half with a serrate crest, claws on exopod with serrate wings, first modified seta large, with crenate wings. Basal claw of exopod of third leg with an accessory process. Fourth leg four-segmented, with five winged claws, basal segment longer than rest of limb and considerably flattened. Vestigial legs are conical processes carrying setae as illustrated.

*Length.*—10.0 mm.

*Male.*—Genital segment small, postero-laterally produced into prominent triangular lobes carrying the fifth legs, sixth leg placed just behind. Abdomen one-jointed and narrowing, postero-laterally produced as in female. Antenna modified as in species of *Caligus.*

*Length.*—7.0 mm.

*Host.*—*Sphyraenae* sp., *S. barracuda.*

*Distribution.*—Gulf of Mexico. Western Atlantic, Hawaii, Indian Ocean.

*Remarks.*—Since its creation by Wilson this species was described in detail by Shiino and Lewis. Though Wilson stated that the fourth segment carries a pair of small dorsal plates it is now certain that

there are no dorsal plates. Therefore, *M. lobodes* cannot be placed in Euryphoridae. If this is so where else can it be accommodated except in *Caligus* ?

The enlargement of the basal segment of the abdomen, the prolongation of the distal corners of the second abdominal segment the apically blunt and lobed claws on the distal segment of the first leg, the double basal claw on the exopod of the third leg and the highly expanded basal segment of the fourth leg make *C. lobodes* (Wilson) stand aloof from the rest. But every one of the above characters is present in one of other species of *Caligus.*

### **Caligus longicaudus** Bassett-Smith

(Fig. 103)

*Caligus longicaudus* Bassett-Smith, 1898a, p. 8, pl. 4, figs. 1-2 ; Wilson, 1905a p. 555 ; Yamaguti, 1963, p. 55 ; Pillai, 1963f, p. 70, fig. 2 ; 1967d, p. 1591 fig. 72 ; Kirtisinghe, 1964, p. 59, fig. 35 ; Margolis *et al.*, 1975, p. 48.

*Female.*—Cephalothorax slightly longer than broad, frontal plates large and projecting, lunules crescentic. Postero-median lobe of cephalothorax about three times as broad as lateral lobes, projecting considerably beyond the latter, posterior sinuses wide open. Fourth segment produced at the base of the legs. Genital segment broad, hemispherical, postero-laterally produced into small lobes. Abdomen indistinctly two-jointed, long-elliptic and narrowing. Caudal rami longer than broad.

Distal segment of antennule club-shaped, some of the setae very long. Basal segment of antenna with small process. Post-antennal process triangular, apically acute. Basal segment of maxilliped with inner median conical process, distal segment slender and short, strongly curved. Base of sternal fork narrow, limbs stout, apically rounded and slightly diverging.

Distal segment of first leg with large ventral setae, claws and spine-like seta subsimilar, former barbed, latter smooth, first claw very short, third very long. First two claws of exopod of second leg stout and naked, third small, first modified seta small. Second and third segments of endopod with a broad patch of denticles. Fourth

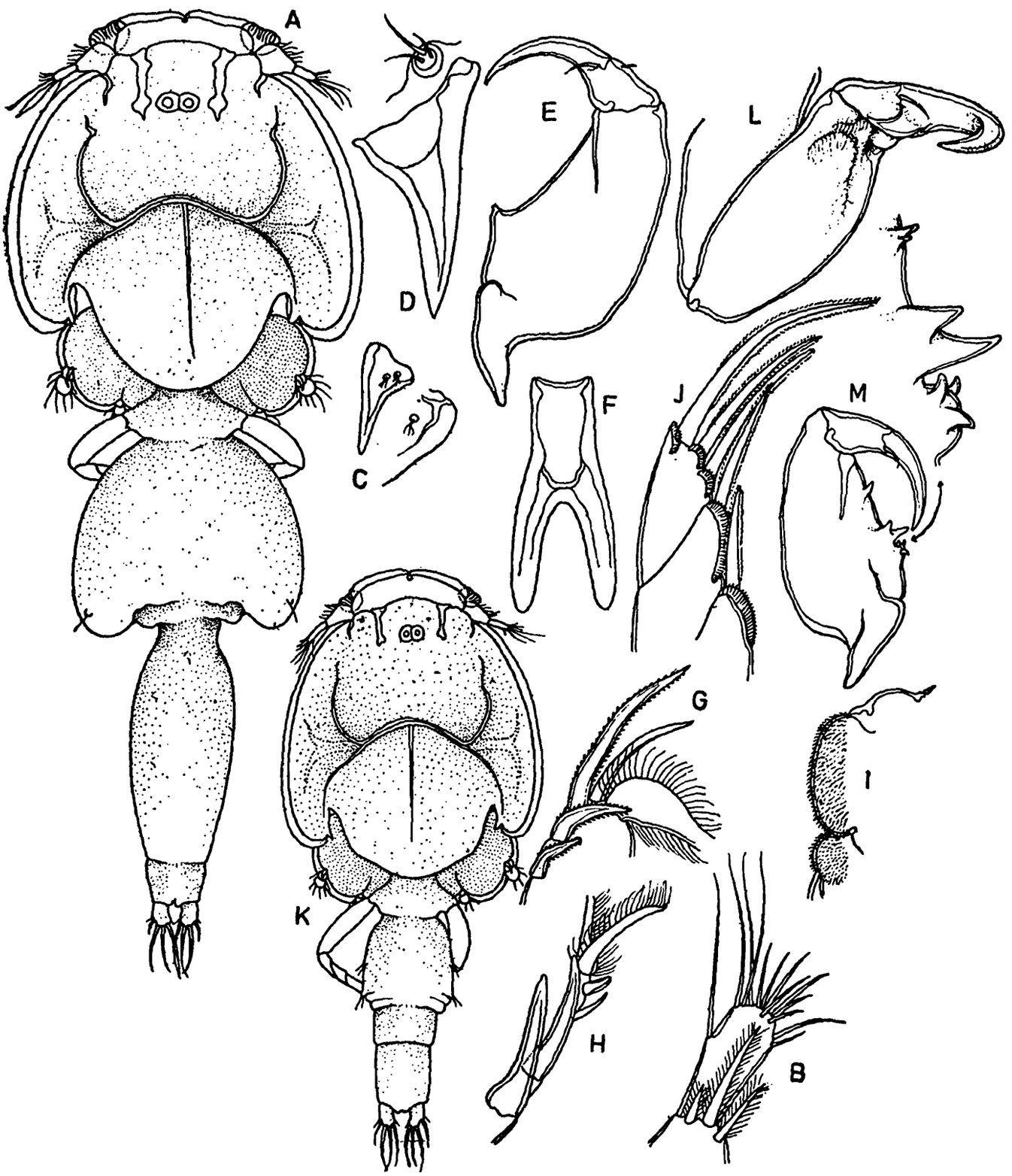


Fig. 103. *Caligus longicaudus* Bassett-Smith : A-J, Female. A, female, dorsal view ; B, antennule ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, same, endopod ; J, leg 4, K-M, male. K, male, dorsal view ; L, antenna ; M, maxilliped.

leg four-segmented, comparatively broad, claws successively increasing in length, last much longer than the penultimate, spiny crest at the base of the first two claws very long, claws with narrow wings.

*Length.*—5.0 mm.

*Male.*—Genital segment small, with median and distal indentations housing the vestigial legs. Abdomen two-segmented, basal segment half as long as distal. Antenna stout, second segment with two projecting adhesion pads, third segment large, basally swollen and distally recurved. Basal segment of maxilliped well armed, with a hemispherical pad surmounted by three curved teeth, followed by a high bifid process and a narrow spine with an accessory process.

*Length.*—2.9 mm.

*Host.*—*Chirocentrus dorab*, *Trichiurus haumela.*

*Distribution.*—India (Bombay, Kerala), Sri Lanka.

## **Caligus longipedis** Bassett-Smith

(Fig. 104)

*Caligus longipedis* Bassett-Smith, 1898c, p. 358, pl. 10, figs. 2-3 ; Wilson, 1905a, p. 508 ; Yamaguti, 1963, p. 56 ; Lewis, 1967, p. 144, figs. 54-56 ; Margolis *et al.*, 1975, p. 49.

*Caligus scabiei* Gnanamuthu, 1950b, p. 114, pl. 2, figs. 17-30 ; Yamaguti, 1963, p. 60, pl. 79, fig. 4 ; Pillai, 1967d, p. 1583, fig. 80 ; Margolis *et al.* 1975, p. 73.

*Caligus lucidus* Heegaard, 1962, p. 158, figs. 54-61.

*Caligus rugosus* Shiino, 1959d, p. 267, figs. 1-2.

*Caligus longipes* Bassett-Smith, 1899, p. 452 ; Wilson, 1905a, p. 556.

*Caligus amplifurcus* Pearse, 1953, p. 199, figs. 29-35 ; Shiino, 1959d, p. 280 figs. 7-8 ; Yamaguti, 1963, p. 49.

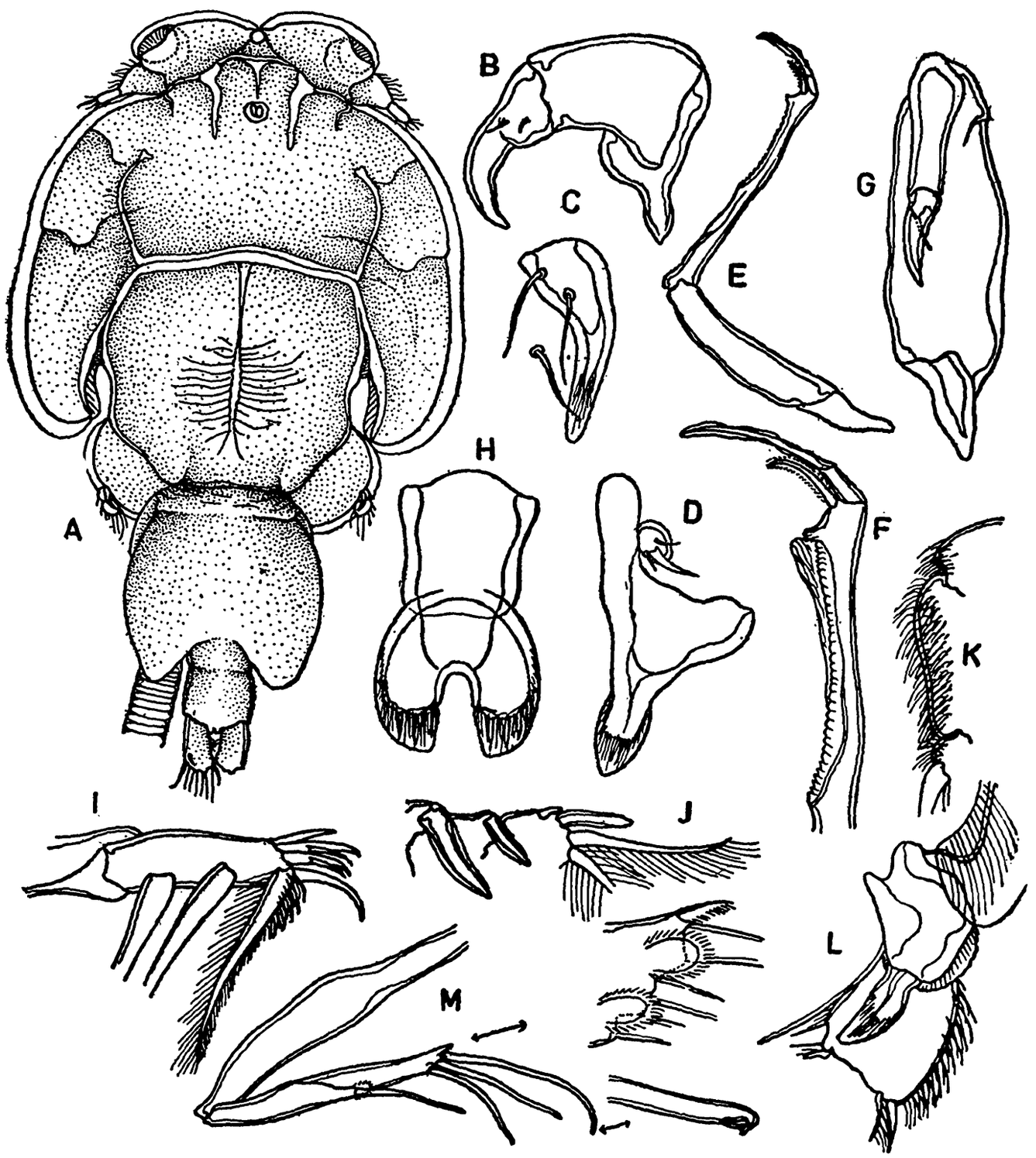


Fig. 104. *Caligus longipedis* Bassett-Smith : A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilla, F, same, tip enlarged ; G, maxilliped ; H, sternal fork ; I, leg 1 ; J, leg 2 exopod ; K, same, endopod ; L, leg 3, basal process of exopod ; M, leg. 4.

*Female.*—Cephalothorax large, well rounded, with a median lateral constriction. Frontal plates large and projecting, lunules comparatively small. Postero-median lobe about four times as broad as lateral lobes and projecting considerably beyond the latter, lobes curving inwards but not closing the posterior sinuses. Fourth segment broad, partially fused with genital segment, latter rather small, as long as broad, with prominent postero-lateral lobes. Abdomen very short, indistinctly two-jointed. Caudal rami much longer than broad.

Basal segment of antennule only slightly longer than broad. Antenna short but stout, basal process stout and flattened, distal segment unusually stout. Post-antennal process large, apically flattened and rounded, associated with three long setules. Post-oral process basally very broad, extreme tip flattened. Basal segment of maxilla short, distal long, half of its inner border serrated, subapically produced inwards making the distal border oblique, claws greatly unequal and bent downwards. Basal segment of maxilliped large, distal slender. Base of sternal fork squarish, limbs highly flattened, outer border convex, inner nearly straight.

Distal segment of first leg with three highly plumose large setae, spine-like seta long and naked, first claw short, second and third with long accessory process. First two claws of exopod of second leg stout, third very small, first seta short but stout, endopod segments hairy. Basal claw of exopod of third leg with stout base carrying a marginal frill, claw flattened, swollen and incurved. Fourth leg very slender, three-segmented, with four long setiform claws, each with a high spiny crest at its base, apex forming a crochet.

*Length.*—4.2 mm.

*Host.*—*Caranx melampygus*, *C. lugubrius*, *C, crysos*, *Trichirus haumela.*

*Distribution.*—Gulf of Aden, Australia, Eastern Pacific, Gulf of Mexico, Hawaii, India (Madras, Kerala).

*Remarks.*—It is surprising that this species with many unique characters was described under several names even by experienced

copepodologists. Though the original description contained very few details Bassett-Smith illustrated the maxilla correctly providing a crucial diagnostic character.

*C. scabiei* was described on a partially dehydrated specimen. I placed the holotype in lactic acid and it immediately regained its original shape. The illustrations based on this specimen show its true identity.

## **Caligus malabaricus** Pillai
(Fig. 105)

*Caligus malabaricus* Pillai, 1961, p. 109, fig. 13 ; 1967d, p. 1579, fig. 41 ; Cressey and Collette, 1970, p. 347, fig. 118 ; Margolis *et al.*, 1975 p. 50.

*Female.*—Cephalothorax broadening backwards, postero-median lobe about three times as broad as lateral lobes, projecting beyond the latter. Frontal plates deep and projecting, lunules large and circular. Genital segment large, as broad as or even broader than cephalothorax, with short anterior neck and large postero-lateral lobes. Abdomen two-jointed, first segment swollen and spindle-shaped, second short.

Antenna robust, basal segment with apically rounded process. Post-antennal process an irregular claw. Post-oral process traingular. Maxilla with moderately large claws with prominent wings. Basal segment of maxilliped stout, with a blunt process. Sternal fork with short narrow base, limbs uniformly broad, apically rounded and prominently diverging.

Basipod of first leg with a patch to denticles, second segment of eopod with three long ventral setae with the basal half of their outer border toothed, spine-like seta long, dorsally plumose, claws strongly curved, second and third with accessory process. First two claws on exopod of second leg stout, third very small. Basal segment of endopod with six long sharp spines, second with about thirty strong teeth in three rows. Rami of third leg placed wide apart. Fourth leg three-jointed, last claw rather long.

*Length.*—4.4 mm.

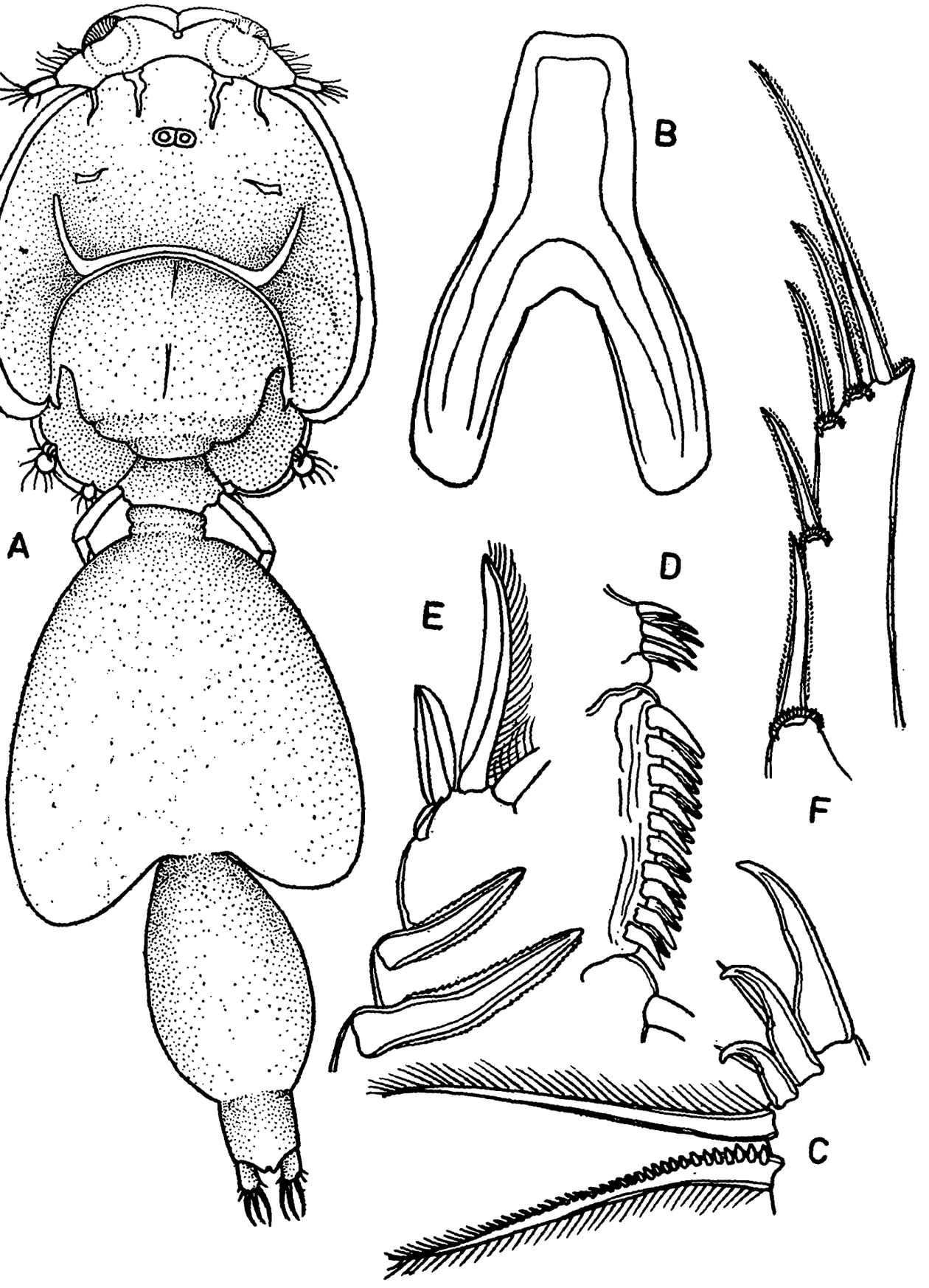


Fig. 105. *Caligus malabaricus* Pillai : A, female, dorsal view ; B, sternal fork ; C, leg 1 ; D, leg 2, endopod ; E, same, exopod ; F, leg 4.

*Host.—Tylosurus crocodilus, Ablennes hians.*

*Distribution.*—India (Kerala), Pacific ocean north of Australia.

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2133/2.

## **Caligus multispinosus** Shen
(Fig. 106)

*Caligus multispinosus* Shen, 1956b, p. 351, pl. 3, figs. 37-48 ; Pillai, 1961, p. 89, fig.2 ; 1967d, p. 1985, fig. 51 ; Yamaguti, 1963, p. 51, pl. 66, fig. 5 ; Kirtisinghe, 1964, p. 56; Silas and Ummerkutty, 1967, p. 967 ; Margolis *et al.*, 1975, p. 54.

*Female.*—Cephalothorax with two pairs of lateral constrictions, postero-median lobe only moderately projecting beyond lateral lobes, latter half as broad as median lobe. Posterior sinuses wide open. Genital segment irregularly rounded, swollen, three fourths the width of cephalothorax. Abdomen long, two-jointed, first segment about four times as long as second. Caudal rami large.

Post-antennal process slender, with broad base, post-oral long and narrow. Claws of maxilla short but stout, prominently winged. Sternal fork with narrow base, rami flat, spically rounded, remotely bracket-like.

Distal segment of first leg with well developed ventral setae., spine-like seta forming with the claws a series, but unlike the claws naked. First two claws on exopod of second leg similar, with narrow serrate wings, third small and naked, endopod segments with patches of stiff setules. Basal claw of exopod of third leg with narrow flange, rami placed wide apart. Fourth leg four-segmented, broad, second segment with a tooth-like inner projection, first four claws sub-similar, pectinate all over, fifth longer than fourth, naked, spiny crests at the base of the first two claws long, others short but prominent.

*Length.*—4.4 mm.

*Male.*—Median lobe of cephalothorax more produced, genital segment small. Abdomen two-segmented, first segment half as

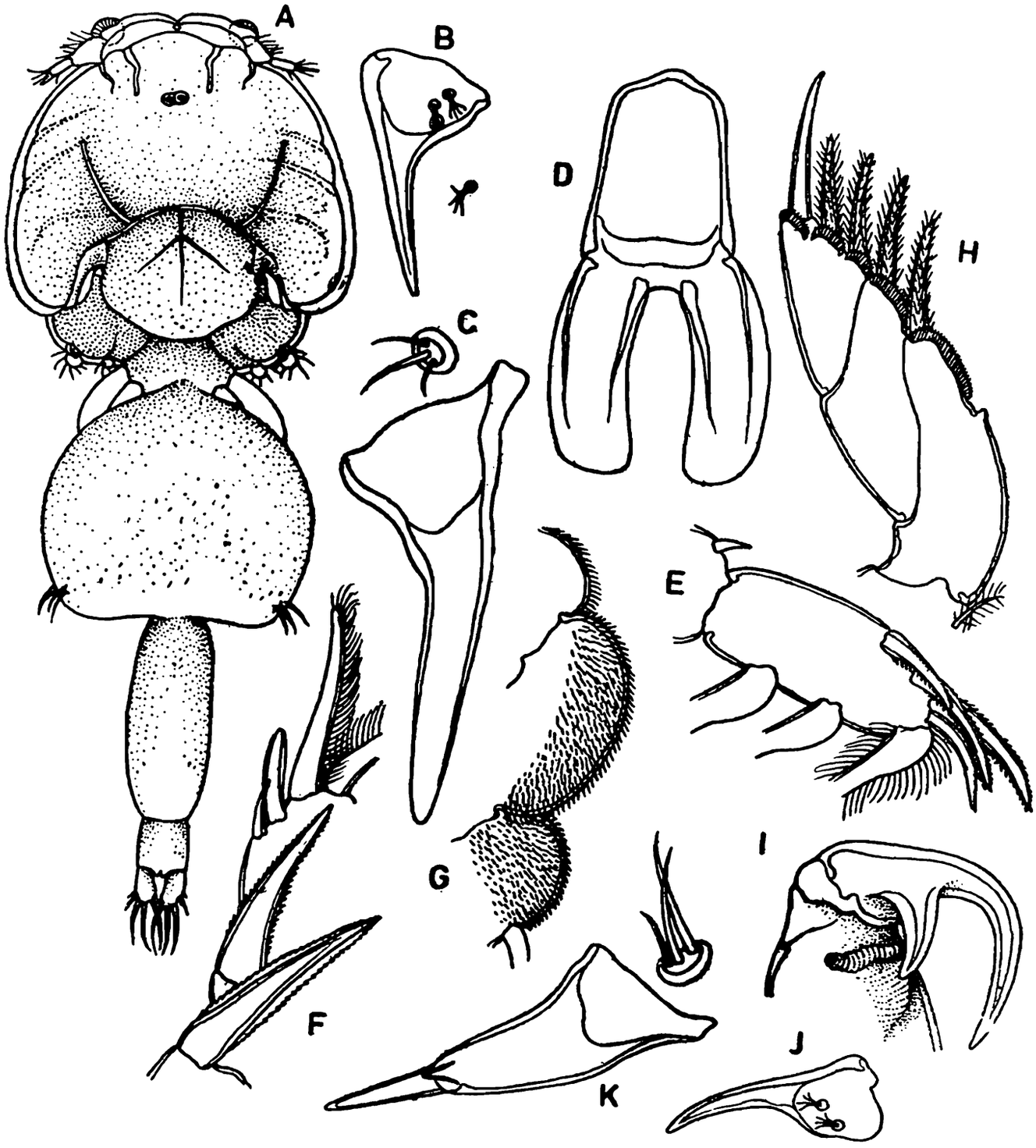


Fig. 106. *Caligus multispinosus* Shen : A-H, Female. A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 4. I-K, Male. I, antenna ; J, post-antennal process ; K, post-oral process and maxillule.

long as second. Post-antennal process more curved, post-oral process more slender, with a partition and a small accessory process. Antenna with very short second segment having two small adhesion

pads, third segment with swollen base carrying a stout accessory claw, main claw long and curved at right angles in the middle.

*Length.*—1.9 mm.

*Host.*—*Stromatoides argenteus* (*Pampus argenteus*).

*Distribution.*—China, India (Kerala).

### **Caligus nengai** Rangnekar, Rangnekar and Murti

*Caligus nengai* Rangnekar *et al.*, 1953, p. 47, figs. 1-13.

*Female.*—Cephalothorax nearly equal in length and width, gradually widening backwards. Frontal plates moderately deep, not projecting much. Postero-median lobe about twice as broad as lateral lobes and clearly projecting beyond the latter, with evenly rounded free border. Fourth segment small, partially fused with genital segment. Genital segment slightly longer than broad, roughly ovate, with distinct but short anterior neck, postero-medially produced over the abdomen. Abdomen very small, one-segmented, attached to ventral side of genital segment. Caudal rami small, partially sunk into the abdomen, with unusually long, heavily plumose setae.

Basal segment of antennule with long setae. Basal segment of antenna with a long strong process, distal segment with long proximal spine-like seta. Post-antennal process an ovate chitinous process. Post-oral process elongate triangular. Maxillule with one? long seta. Maxilla slender, distal segment longer than basal, with two very unequal claws. Basal segment of maxilliped slender, distal shorter than basal, with a large spine-like seta. Sternal fork with roughly squarish base, limbs subparallel and apically slightly expanded and rounded.

Basipod of first leg with a long dorsal seta, vestigial endopod oblong, prominently spinulose. Base segment of exopod with small dorsal distal spine, second segment with three claws, a small spine and three long setae, claws successively decreasing in length, each

with a ventral frill, second and third with accessory process. Basal segment of exopod of second leg with a long claw, second with a short claw, third with seven setae?, first two naked. Claw of exopod of third leg with large base and small process, latter with outer flange, exopod clearly two-jointed. Velum comparatively small. Fourth leg four-segmented, distal segment with three claws?, apical claw much smaller than the others.

*Length.*—2.48 mm.

*Host.—Arius nenga.*

*Distribution.*—India (Bombay).

*Remarks.*—Rangnekar *et al* have given only very few details but the peculiar features exhibited by caligid parasites of cat fishes are easily discernible.

*C. nengai* resembles *C. arii* in the overall structure of the various appendages but differs in the shape of the genital segment and in the length of the abdomen. There is unusual similarity between *C. distortus* and *C. nengai*. The general shape of the body is the same except that in *C. distortus* the genital segment is asymmetrical and distorted. The abdomen is identical and the caudal rami have long setae. In the shape of the antennule, antenna, post-antennal and post-oral processes and the sternal fork there is hardly any difference. But the maxillipeds are apparently different, *C. distortus* having a short distal segment and the basal segment having three processes which have not been mentioned by Rangnekar *et al.* Of particular significance is the small size of the spine-like seta and the shape and size of the three claws on the distal segment of the first leg, the very small size of the basal spine of the exopod of the third leg and the presence of only two claws on the distal segment of the fourth leg. The third small spine mentioned by Rangnekar *et al* is not a spine but the projecting setiferous lobe. I have very little doubt that *C. distortus* is the same as *C. nengai*. But in view of the fact that *C. distortus* was described with the help of a single apparently distorted specimen and I had no chance to study specimens of *C. nengai* I leave this question open.

## **Caligus parapetalopsis** Hameed and Pillai
(Fig. 107)

*Caligus parapetalopsis* Hameed and Pillai, 1973c, p. 114, figs. 1-21.

*Female.*—Cephalothorax perfectly circular, postero-lateral lobes curving inwards but not closing the posterior sinuses. Frontal plates moderately deep and projecting, lunules of average size. Genital segment considerably enlarged, broader than cephalothorax, antero-laterally shoulder-like and postero-laterally produced into large apically rounded lobes reaching far beyond the hind border of the segment. Abdomen one-segmented, expanded but narrower than cephalothorax, postero-laterally forming prominent lobes.

Second segment of antennule very long and slender. Basal segment of antenna with a small process, distal segment strongly falcate. Post-antennal process well developed, base produced into a conical process, main claw with broad outer flange. Post-oral process with broad base and narrow apically rounded flanged claw, with a small blunt accessory claw. Basal segment of maxilliped with proximal bulge. Sternal fork with narrow, diverging, apically flanged limbs.

Claws on distal segment of first leg long and ventrally spiny, second and third with accessory process, spine-like seta long and naked. Claws on exopod of second leg successively decreasing in size, with broad serrate flange, basal segment of endopod expanded, with a crest of spines, others hairy. Basal claw of exopod of third leg strongly curved. Fourth leg four-segmented, basal segment broad, claws subsimilar.

*Length.*—4.0 mm.

*Male.*—Genital segment conical, broadening backwards. Abdomen one-segmented, squarish. Antenna with the usual modifications, first and second segments with two adhesion pads each, third segment strongly curved, with two spine-like setae. Post-oral process with longer accessory process, transversely rugose. Basal segment of maxilliped with four processes, distal segment apically pustulose.

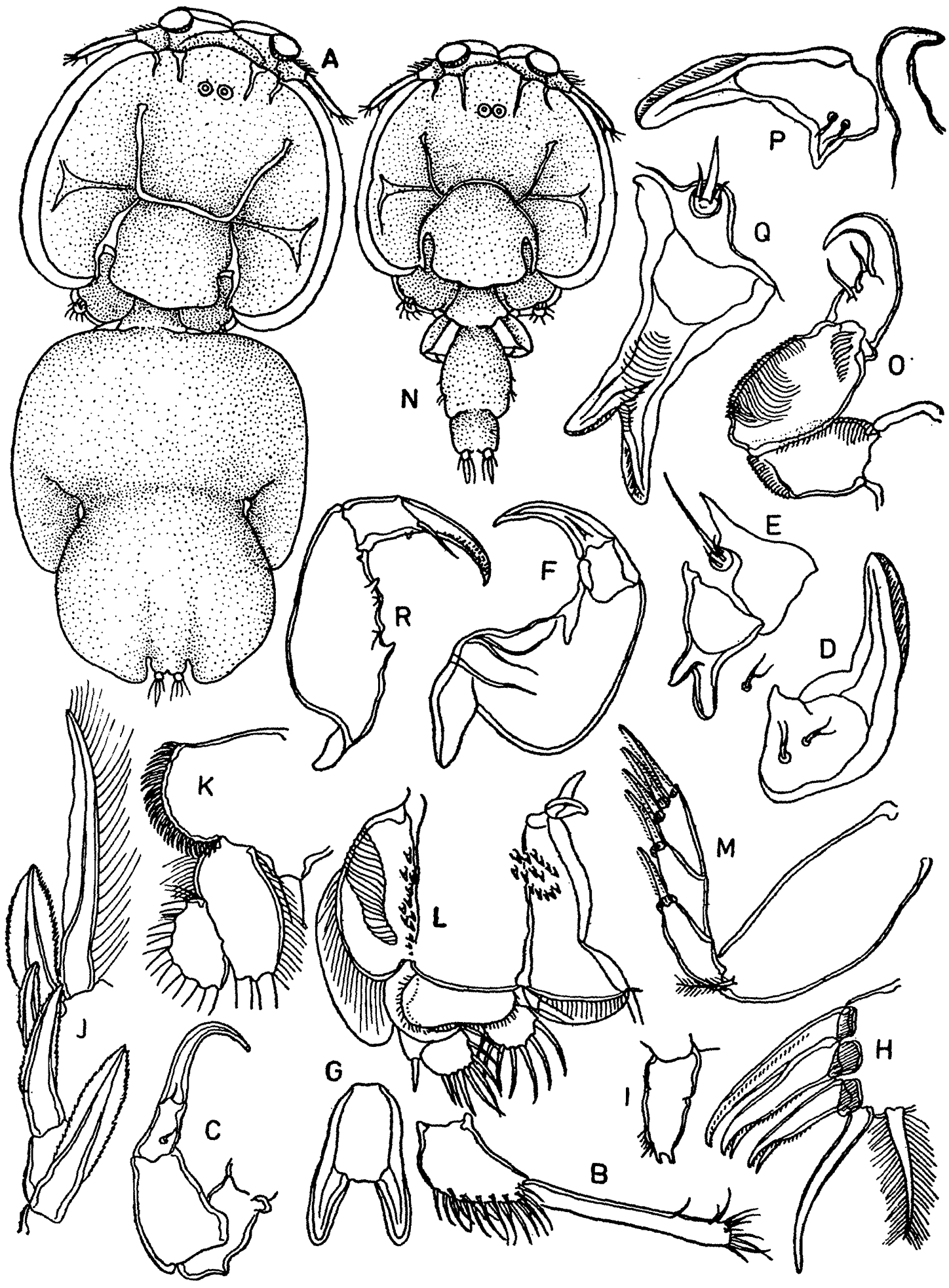


Fig. 107. *Caligus parapetalopsis* Hameed and Pillai : A-M, Female. A, female, dorsal view ; B, antennule ; C, anntenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, maxilliped ; G, sternal fork ; H, leg 1 ; I, same, vestigial endopod ; J, leg 2, exopod ; K, same, endopod ; L, leg 3 ; M, leg 4. N-R, Male ; N, male, dorsal view ; O, antenna ; P, post-antennal process ; Q, post-oral process and maxillule ; R, maxilliped.

*Length.*—2.5 mm.

*Host.—Zonichthys nigrofasciata.*

*Distribution.*—India (Kerala).

*Holotype.*—In the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2134/2.

*Remarks.*—The extreme flattening of the genital segment of this species makes it resemble many other caligid genera like *Parapetalus*, *Abasia* and *Alicaligus*, making the validity of these genera suspect. But at present nothing worthwhile can be done in the matter.

*C. parapetalopsis* also shows the peculiar combination of characters of caligids parasitic on carangid fishes.

## **Caligus pelagicus** Kurian
(Fig 108)

*Caligus pelagicus* Kurian, 1955, p. 103, figs. 1-18 ; Pillai, 1967d, p. 1595, fig. 82 ; Margolis *et al.*, 1975, p. 59.

*Male.*—Cephalothorax comparatively large, broadening backwards, postero-median lobe very broad, evenly rounded and projecting far beyond lateral lobes. Posterior sinuses fully open. Frontal plates projecting, lunules circular. Fourth segment large. Genital segment postero-laterally produced into conical lobes carrying the vestigial legs. Abdomen two segmented, first segment very small. Caudal rami longer than broad.

Basal segment of antenna with one and second with three adhesion pads, third segment short but broad, apically trifid and with large spine-like seta. Post-antennal process with large base, claw short, apically blunt and flanged. Post-oral process elengate triangular, with a bulging adhesion pad, distally flattened. Claws of maxilla long, placed wide apart. Basal segment of maxilliped large, with a

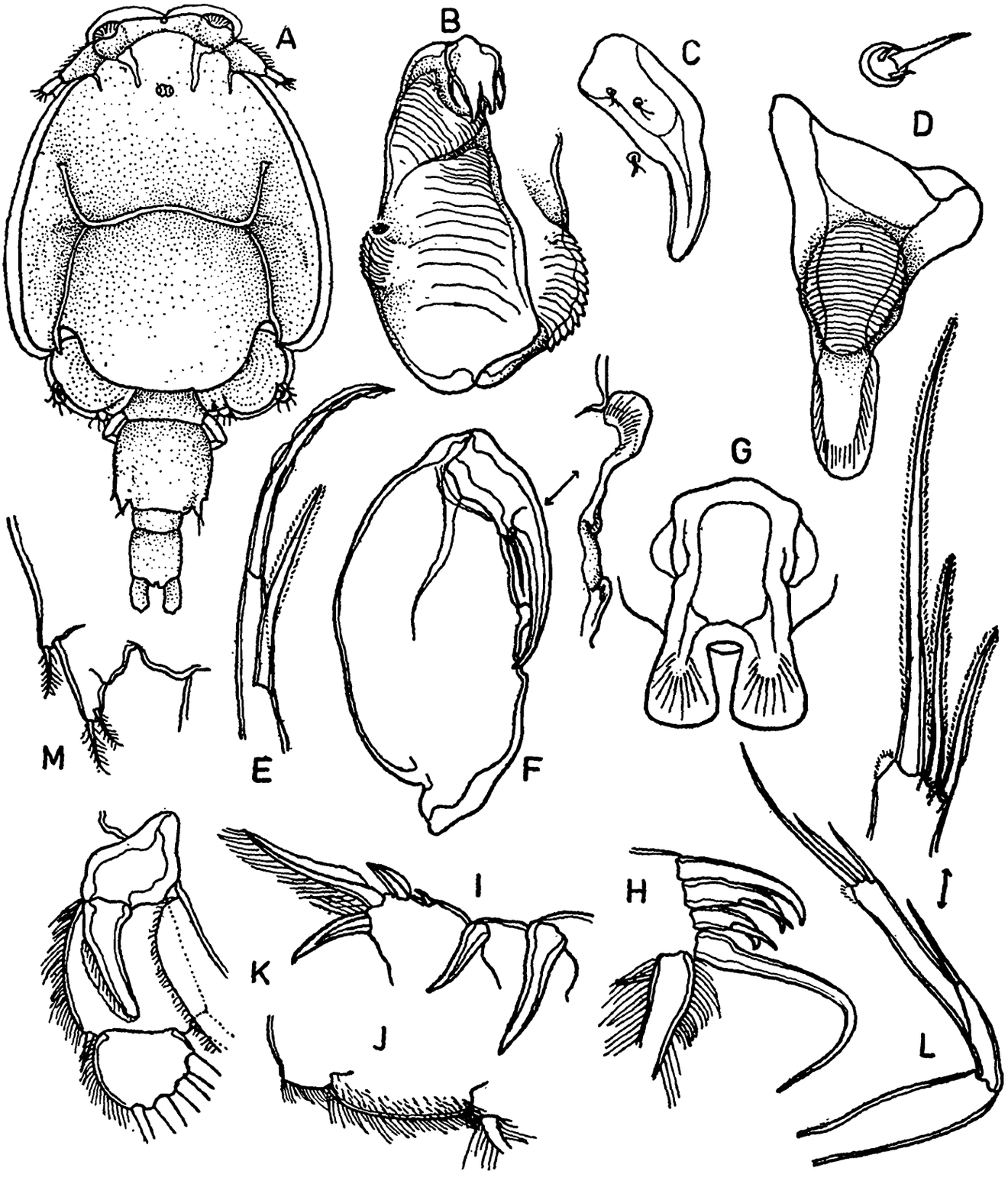


Fig. 108. *Caligus pelagicus* Kurian : A, male, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilla ; F, maxilliped ; G, sternal fork ; H, leg 1 ; I, leg 2, exopod ; J, same, endopod ; K, leg 3, exopod ; L, leg 4.

small proximal elevation followed by two rounded processes, distal segment divided into broad base and slender claw, base with an unusually long spine. Sternal fork with stout roughly squarish base and very short flattened limbs widening distalwards, distal border rounded.

Setae on distal segment of first leg large. Spine-like seta long and naked, claws smooth and curved, accessory process large. First two claws of exopod of second leg large and bent downwards, third small, endopod segments hairy. Basal claw of exopod of third leg flanged externally, curving inwards. Fourth leg slender, three-segmented, claws long, slender and nearly straight, last claw twice as long as the penultimate.

*Length.*—3.5 mm.

*Female.*—Cephalothorax more prominently widening backwards, postero-median lobe narrower and more produced. Genital segment swollen, broader than long. Abdomen short, one-jointed. Antennule rather short. Basal segment of antenna with long sharp process, distal slender.

*Length.*—3.1 mm.

*Host.*—Planktonic.

*Distribution.*—India (Kerala).

*Holotype.*—Male in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C3213/1.

*Remarks.*—The type specimen, a male deposited in the Indian Museum is described above. No allotype was designated. As I could not get a female for study the above short description of the femal is from Kurian's publication.

This species has several very diagnostic characters among which the shape of the maxillipeds, sternal fork and fourth leg is worth special mention.

## **Caligus phipsoni** Bassett-Smith
(Fig. 109)

*Caligus phipsoni* Bassett-Smith, 1898a, p. 7, pl 3, figs. 3-4 ; Wilson, 1912a, p. 238, pl. 32, fig. 22, pl. 33, figs. 23-27 ; Pillai, 1963f, p. 58, fig. I ; Yamaguti, 1963, p. 58, pl. 78, fig. 1 ; Margolis *et al.*, 1975, p. 61.

*Female.*—Cephalothorax large, with projecting frontal plates, lunules large. Postero-median lobe projecting far beyond lateral lobes, posterior sinuses fully open. Genital segment slightly longer than broad, broadening backwards. Abdomen one-segmented, narrow. Caudal rami longer than broad.

Cephalothoracic appendages without any special features. Sternal fork with large narrow base, limbs of the fork short, slightly diverging.

First leg short but deep, vestigial endopod with a spine, distal segment of exopod with normally developed claws, second and third with accessory process, spine-like seta much longer than the claws, dorsally hairy, first ventral seta longest. First two claws on exopod of second leg large, with broad serrate flange, third very small, first seta with broad wings, basal segment of endopod with a row of stiff hairs, second segment with three rows of short teeth. Apron of third leg with outer adhesion pad, claw of exopod curving inwards and externally flanged. Fourth leg three-jointed, basal segment as long as rest of limb, claws with moderately broad wings, fifth claw one and a half times as long as fourth.

*Length.*—3.9 mm.

*Male.*—Postero-median lobe of cephalothorax more produced, genital segment pear-shaped, abdomen two-segmented, first segment short and immersed in genital segment, second slightly widening backwards.

Antenna modified, second segment with three adhesion pads, third segment short but stout, apically divided into four teeth and with a small spine-like seta. Post-antennal process a strong claw with slightly enlarged base (in the female a chitinous plate). Basal

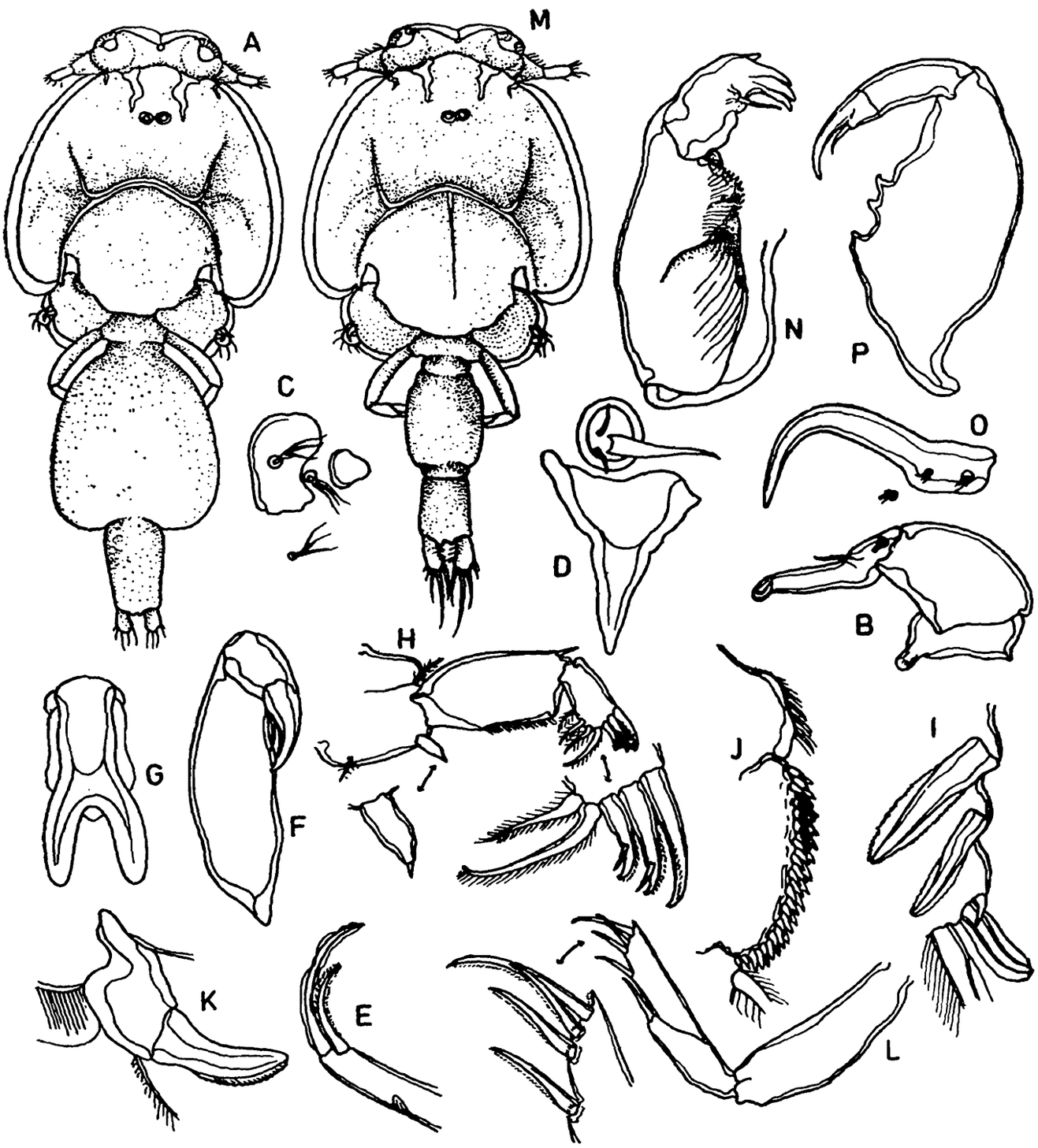


Fig. 109. *Caligus phipsoni* Bassett-Smith ; A-L, Female. A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilla ; F, maxilliped ; G, sternal fork ; H, leg 1 ; I, leg 2, exopod ; J, same, endopod ; K, leg 3, basal process of endopod ; L, leg 4. M-P, Male, M, male, dorsal view ; N, antenna ; O, post-antennal process ; P, maxilliped.

segment of maxilliped with a blunt proximal process followed by two sharp processes, second segment stout, with a clear division, distal part with a long spine-like seta.

*Length.*—2.5 mm.

*Host.*—*Cybium guttatum*, *Polynemus plebeius*, *P. tetradactylum*, *Plectropoma cyanostigma.*

*Distribution.*—Java, Sydney, India (Kerala, Bombay).

**Caligus planktonis** Pillai
(Fig. 110)

*Caligus planktonis* Pillai, 1978 (in press).

*Female.*—Cephalothorax clearly longer than broad, frontal plates coalesced with the cephalothorax, membranous flange rather narrow, strengthened by several stiff hairs. Postero-median lobe of cephalothorax very broad, about five times as broad as lateral lobes and reaching far beyond the latter and slightly overlapping the fourth segment. Fourth segment partially fused with genital segment. Genital segment very large, longer than cephalothorax, steadily widening backwards and postero-laterally forming apically rounded triangular lobes. Abdomen apparently two-jointed, short. Egg tubes nearly as long as body.

Antennule with comparatively stout setae. Antenna robust, basal segment produced into a conical process, distal segment with a spine-like process. Post-antennal process stout but narrow, associated with three stout setae. Post-oral process triangular, followed by a large apically rounded accessory process. Maxillule with three comparatively short setae. Second segment of maxilla much longer than first, outer flange apically drawn out, claws bilaterally pectinate. Maxilliped rather slender and elongated, basal segment with a proximal process, distal segment short, with a tooth and a spine. Sternal fork with apically blunt, irregular, strongly diverging limbs.

Basipod of first leg strongly spiny, distal segment of exopod with three short claws, second and third with accessory process,

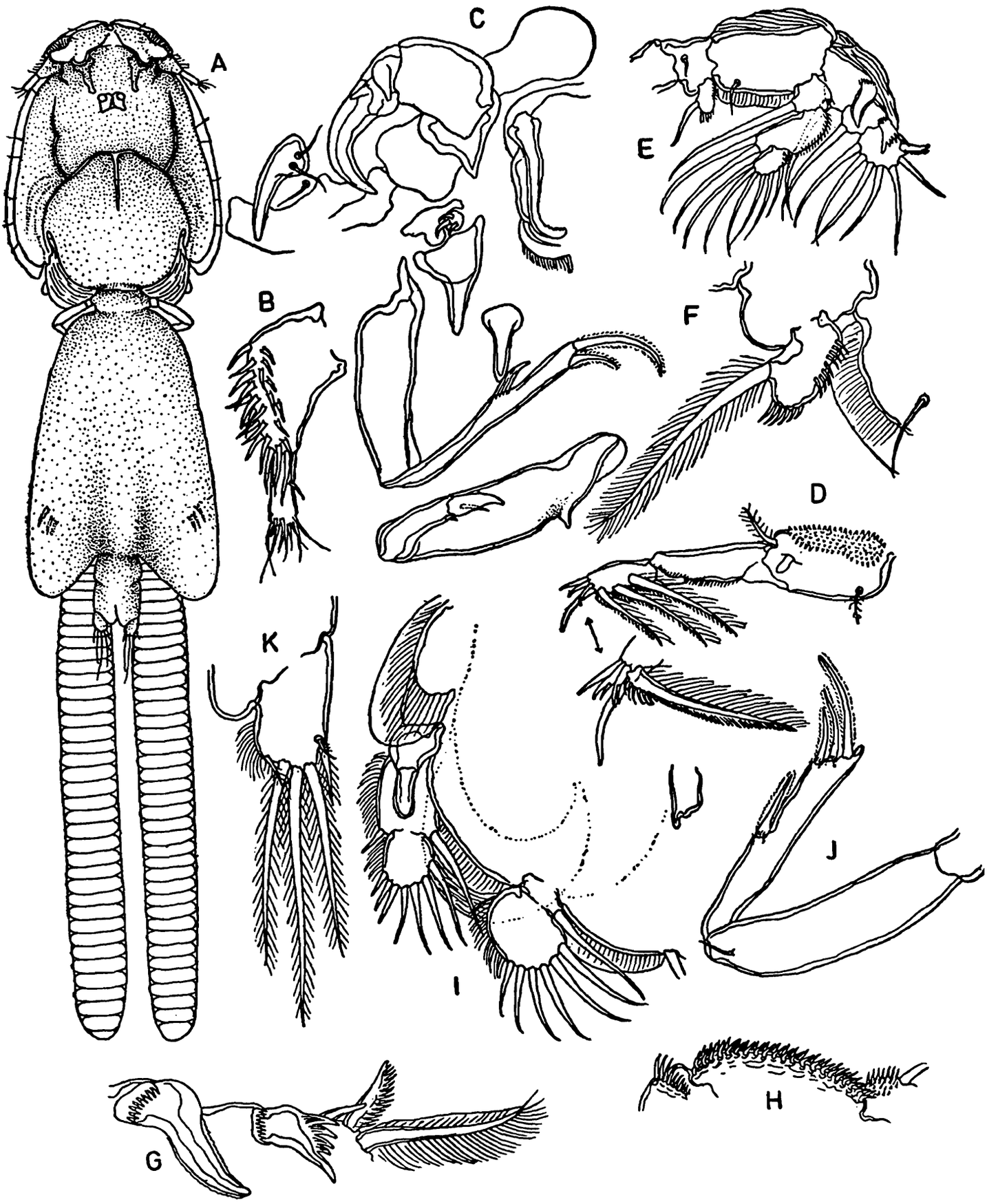


Fig. 110. *Caligus planktonis* sp. nov. ; A, female, dorsal view ; B, antennule ; C, antenna, post-antennal process, post-oral process, accessory process, maxillule, maxilla and maxilliped ; D, leg 1 ; E, leg 2 ; F, same, process on basipod ; G, same exopod ; H, same, endopod ; I, leg 3 ; J, leg 4 ; K, caudal ramus.

spine-like seta long and naked, ventral setae large, externally with pectinate flange and internally plumose. First segment of protopod of second leg with an oblong lobe carrying a long plumose seta and two marginal patches of strong spines. First claw of exopod stout and curved, with feebly serrate flange, second claw externally cut into five teeth, third naked and small, first modified seta strongly spiny on outer border, inner border naked. Endopod segments with strong spines. Basipod of third leg produced backwards, dorsally visible as two somewhat muscular lobes, basal process of exopod blunt and directed straight downwards. Fourth leg two-jointed, second segment with four claws, first exactly in the middle.

*Length.*—2.3 mm.

*Host.*—Planktonic.

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2135/2.

*Remarks.*—This species closely resembles *C. amblygenitalis* Pillai (1961) in the shape of the body, antenna, post-antennal process, post-oral process including the accessory process, the armature of the distal segment of the first leg and in the nature of the claws on the exopod of the second leg. However, in *C. planktonis* the first modified seta of the exopod of the second leg is spiny but winged in *C. amblygenitalis*, the endopod is spiny in *C. planktonis* but pectinate in *C. amblygenitalis*. The fourth leg is two-jointed in *C. planktonis* but three-jointed in *C. amblygenitalis*. The accessory lobe on the basipod of the second leg and the two-jointed fourth leg distinguish *C. planktonis* from all the rest.

## **Caligus platurus** Kirtisinghe
(Fig. 111)

*Caligus platurus* Kirtisinghe, 1964, p. 61, figs. 38-48 ; Pillai, 1966, p. 128, fig. 4 ; 1967d, p. 1581, fig.48 ; Margolis *et al.*, 1975, p. 62.

*Female.*—Cephalothorax large and rounded, lateral borders with three pairs of small incisions, postero-median lobe as broad as

## **Caligus polycanthi** Gnanamuthu

*Caligus polycanthi* Gnanamuthu, 1950d, p. 159, figs. 1-6 ; Shiino, 1959c, p. 338, figs. 2-3 ; Yamaguti, 1963, p. 58 ; No. 1966a, p. 163, figs. 1-19 ; Margolis *et al.*, 1975, p. 62.

*Caligus canthidermis* Yamaguti and Yamasu, 1959, p. 112, pl. 7, figs. 124-135 ; Yamaguti, 1963, p. 50, pl. 59, fig. 1 ; Margolis *et al.*, 1975, p. 62.

Female.—Cephalothorax slightly longer than broad, frontal plates low, lunules of moderate size. Postero-median lobe very slightly projecting beyond lateral lobes, more than twice as broad as the latter. Posterior sinuses wide open. Genital segment enlarged, three-fourths the width of cephalothorax, postero-laterally produced into large lobes. Abdomen short, one-segmented, basally narrow. Caudal rami fused with abdomen.

Basal segment of antenna large, distal segment strongly curved. Post-antennal process large, strongly curved. Post-oral process strong, slightly curved. Basal segment of maxilliped with small inner process, second segment with well marked unguis, Sternal fork with diverging apically blunt limbs.

Distal segment of first leg with large ventral setae, spine-like seta smooth, longer than the claws. Claws on exopod of second leg successively decreasing in size, endopod segments haiay. Basal claw of exopod of third leg curving inwards. Fourth leg three-segmented. Claws rather week and winged.

*Length.*—2.5 mm.

*Male.*—Cephalothorax as long as broad, postero-median lobe one and a half times as broad as lateral lobes. Genital segment small, abdomen as in female. Basal segment of antenna with one and second with two adhesion pads, third segment short but stout, with two spines. Post-antennal process longer. Basal segment of maxilliped with large double boss.

*Length.*—2.2 mm.

*Host.*—*Balistes maculatus*, *B. fuscus*, *Echeneis* sp., *Aluteres scriptus*, *Conthidermis maculatus*.

*Distribution.*—India (Madras), Japan, Formosa, Bay of Bengal.

Distal segment of antennule long and slender. Antenna slender, with long well curved distal segment. Post-antennal process short, apically blunt. Post-oral process with small accessory lobe, distal part flanged. Sternal fork with stout base, rami short and slender, with broad outer flange.

First leg slender, distal segment with small ventral setae, spine-like seta long and naked, claws slender, second and third with subsidiary process. First two claws of exopod of second leg large, with serrate wings, third small, basal segment of endopod with a crest of slender long spines, second and third segments hairy. Basal claw of exopod of third leg strongly curved. Fourth leg four-segmented, basal segment broad, claws subsimilar.

*Length.*—3.7 mm.

*Host.—Caranx melampygus.*

*Distribution.*—Sri Lanka, India (Kerala).

*Type* in the Colombo Museum.

## **Caligus platytarsis** Bassett-Smith
## (Fig. 112)

*Caligus platytarsis* Bassett-Smith, 1898b, p. 83, pl. 4, fig. 2 ; Wilson, 1905a, p. 504 ; Yamaguti, 1963, p. 58 ; Pillai, 1967d, p. 1592, fig. 79 ; 1969, p. 152, figs. 9-23 ; Margolis *et al.*, 1975, p. 62.

*Caligus bomdayensis* Rangnekar, 1955a, p. 55, figs. ; Kabata, 1965b, p. 112, fig. 1A.

*Female.*—Cephalothorax moderately large, broadest behind. Postero-median lobe one and a half times as broad as lateral lobes. posterior sinuses wide open. Frontal plates low, lunules small, Fourth segment fairly large. Genital segment somewhat hemispherical, postero-laterally angular, hind border nearly transverse-Abdomen long slender, apparently, two-segmented. Caudal rami large, oblong.

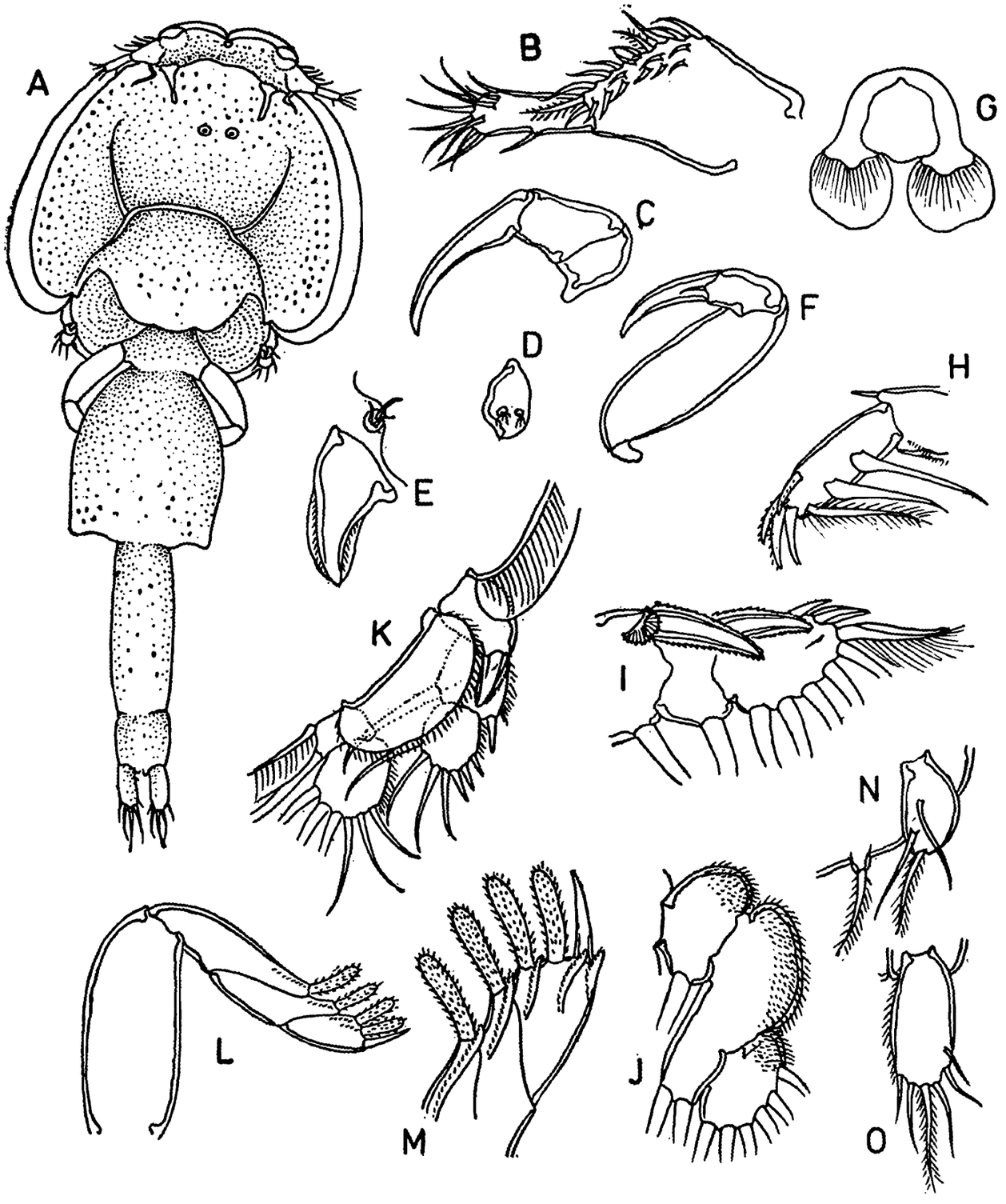


Fig. 112. *Caligus platytarsis* Bassett-Smith : A, female, dorsal view ; B, antennule ; C, antenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, maxilliped ; G, sternal fork ; H, leg 1 ; I, leg 2, exopod ; J, same, endopod ; K, leg 3 ; L, leg 4 ; M, same, tip enlarged ; N, legs 5-6 ; O, caudal ramus.

*Distribution.*—India (Kerala).

*Holotype*—Female and allotype male in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2136/2 & C2137/2.

*Remarks.*—This species always appears along with *C, hamruri* from which it can be easily distinguished by the short one-segmented abdomen, strongly serrated claw of the maxilla and the toothed claws of the exopod of the second leg which are all unique characters.

## **Caligus productus** Dana
(Fig. 114)

*Caligus productus* Dana, 1852, p. 56 ; Wilson, 1905a, p. 480, pl. 14, figs. 162-170 ; Shiino, 1959a, p. 14, figs. 6-8 ; Yamaguti, 1963, p. 58, pl. 78, fig. 3 ; Lewis, 1967, p. 116, figs, 43-45 : Margolis *et al.*, 1975, p. 64.
*Caligus monacanthi* Kroyer, 1863, p. 59, pl. 3, fig. 2.
*Caligus lobatus* Wilson, 1935b, p. 1, pl. 1 figs. 1-10.
*Caligus katuwo* Yamaguti, 1936b, p. 6, pl. 4, fig. 55, pl. 5, figs. 56-68.
*Caligus maculatus* Heegaard, 1962, p. 157, figs, 45-53.

*Female.*—Cephalothorax broadening backwards, postero-laterally with scattered spinules, postero-median lobe more than twice as board as lateral lobes, frontal plates prominently projecting Genital segment large, slowly widening backwards, postero-laterally forming very large lobes. Abdomen long, two-jointed, first segment narrower but longer than second. Caudal rami much longer than broad.

Basal segment of antennule rather stout. Antenna normal. Post-antennal process stout and elongate-triangular. Post-oral process comparatively long and well developed. One of the setae of maxillule very stout, others small. Claws of maxilla short. Basal segment of maxilliped with a small process, distal well curved. Limbs of sternal fork as long as base, diverging and bracket-shaped, with narrow flange.

Distal segment of first leg without ventral setae, spine-like seta long, dorsally hairy, claws decreasing in length from first to third.

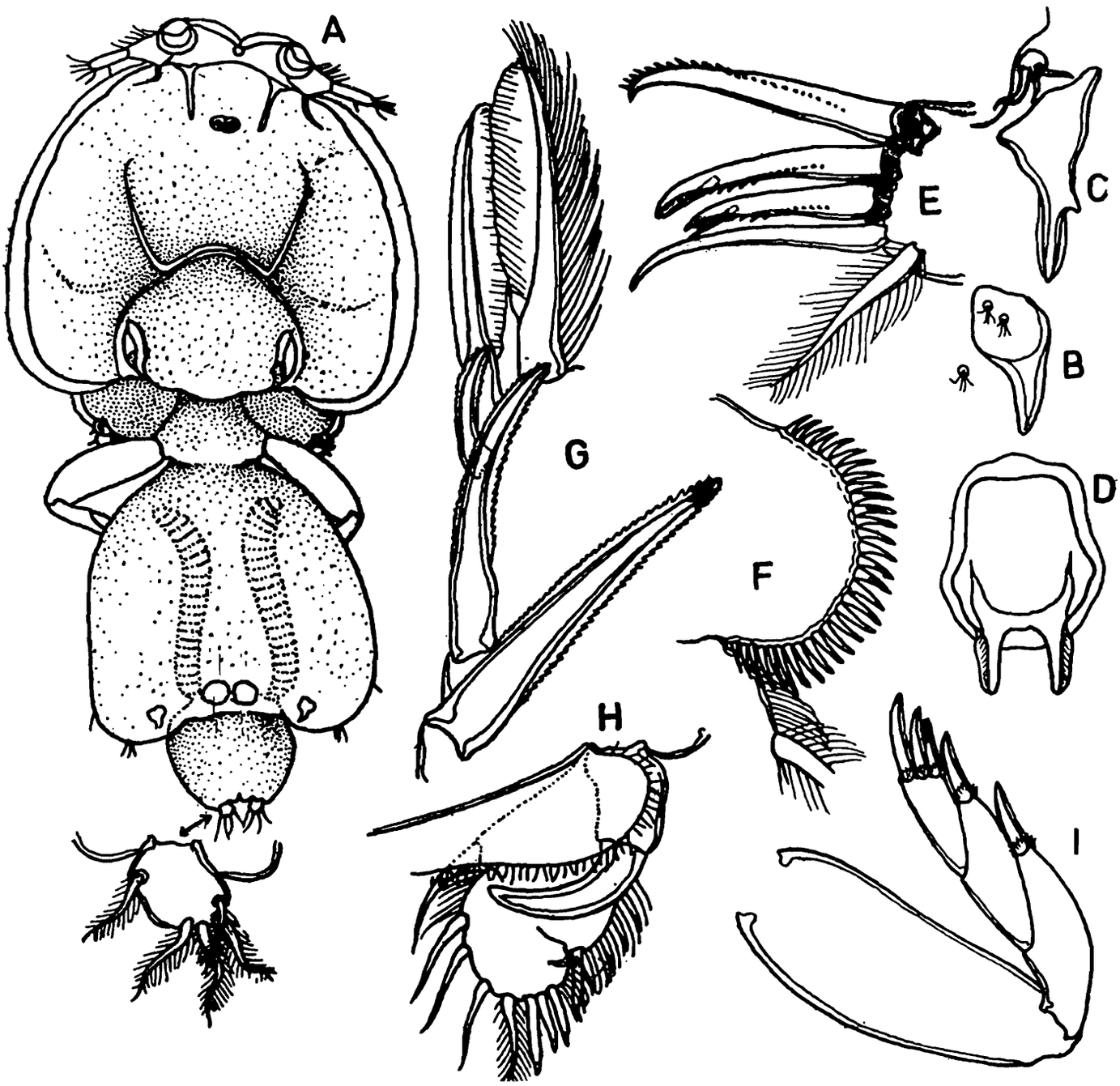


Fig. 111. *Caligus platurus* Kirtisinghe : A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 ; F, leg 2, endopod ; G, same, exopod ; H, leg 3, exopod ; I, leg 4.

lateral lobes and not projecting beyond the latter. Frontal plates low, lunules small and projecting. Genital segment highly expanded, postero-laterally broadly rounded. Abdomen short, one-jointed and swollen, partly sunk into the genital segment, narrowing backwards. Caudal rami small, sunk into the abdomen.

*Remarks.*—The somewhat erroneous description of this species by Gnanamuthu was corrected by Shiino and Ho. *C. polycanthl* can be easily identified by the shape of the genital segment and the nature of the setae on the distal segment of the first leg. They are normally plumose on the inner side but the plumes basally fuse on the outer side. Ho stated that no other species has post-maxillary processes as in *C. polycanthi.* But several species, for example. *C. amblygenitalis* Pillai and *C. planktonis* Pillai have this.

**Caligus priacanthi** Pillai
(Fig. 443)

*Caligus priacanthi* Pallai, 1961, p. 104, fig. 11 ; 1964b, p. 63 ; 1967d, p. 1975, fig. 33 ; Margolis *et al.*, 1975, p. 63.

*Female.*—Cephalothorax roughly triangular and broad, postero-median lobe about four times as broad as lateral lobes and projecting far beyond them, its distal border nearly transverse. Frontal plates shallow, lunules small. Posterior sinuses wide open. Genital segment large. Abdomen very short, one-jointed.

Antenna stout, basal segment with small rounded process, distal long. Post-antennal process a stout claw. Post-oral process apically acute. Claws of maxilla greatly unequal, subapical short, with broad wings, apical long, bilaterially serrated. Maxilliped stout, basal segment with a conical apically acute process. Sternal fork with short comparatively narrow base and diverging, flanged, apically rounded limbs.

Distal segment of first leg with well developed vental setae, spine-like seta and claws subsimilar and naked, arst claw very small. First two claws on exopod of second leg very long and curved downwards, externally armed with a row of blunt teeth. third claw very small. Second and third endopod segments with a patch of spinules. Fourth leg three-segmented, rather slender, claws with broad serrate wings.

*Length.*—2.9 mm.

*Male.*—Cephalothorax as in female, frontal plates deep, lunules large. Genital segment small. Abdomen short, two-segmented,

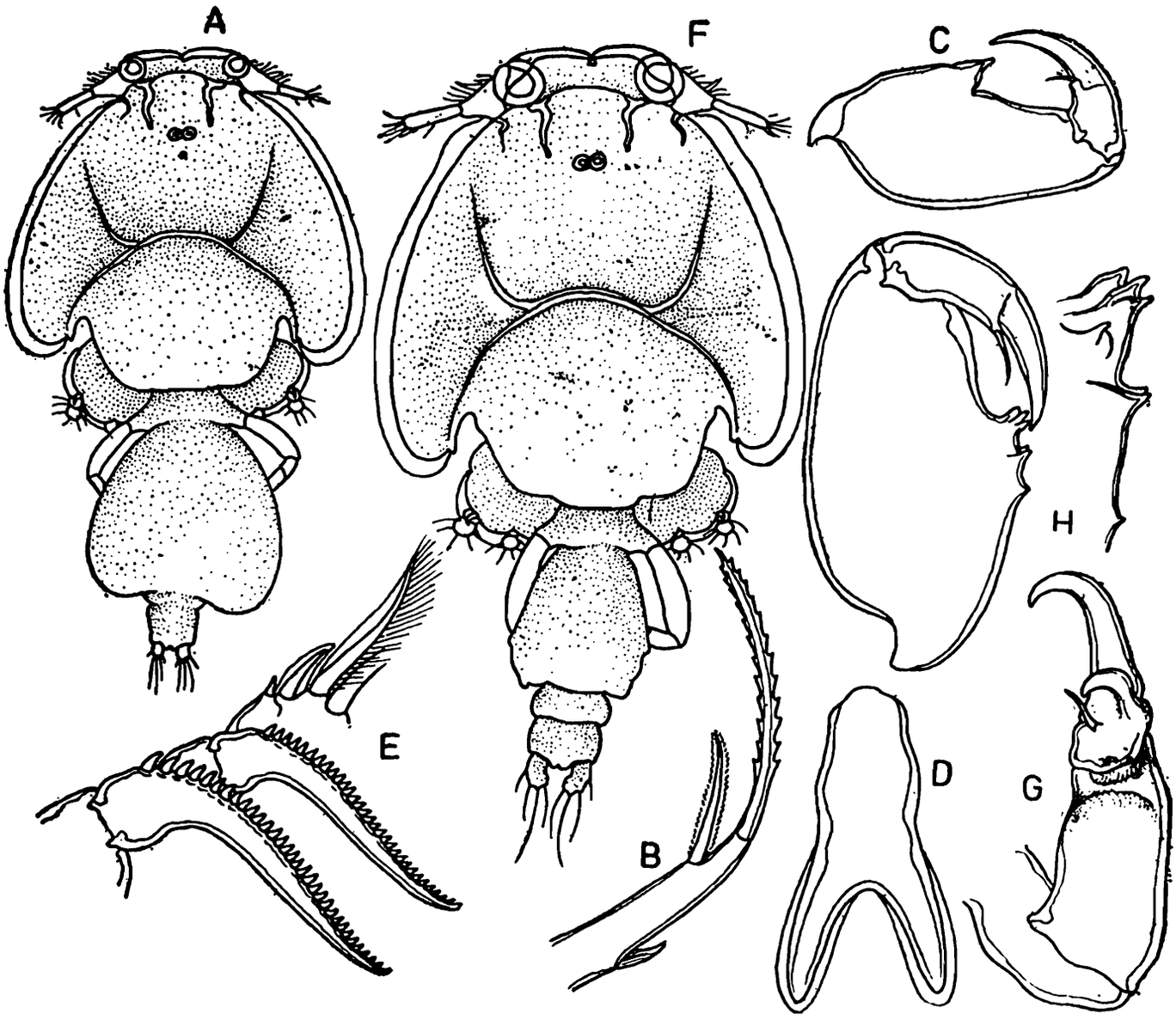


Fig. 113, *Caligus priacanthi* Pillai : A-E, Female. A, female, dorsal view ; B, maxilla; C, maxilliped; D, sternal fork; E, leg 2, exopod. F-H, Male. F, male, dorsal view ; G, antenna ; H, maxilliped.

first segment slightly shorter. Caudal rami longer than broad. Antenna slender, second segment with two small adhesion pads, third segment with swollen base carrying a stout accessory claw and a spine, main claw apically curved. Post-antennal process stouter than in female, Basal segment of maxilliped very stout, its median inner part produced into seven teeth, distal three very high, second segment with a partition carrying a long spine.

*Length.*—1.9 mm.

*Host.—Priacanthus hamrur.*

Antenna slender, basal segment with rounded process, distal segment long and slightly curved. Post-antennal process a simple chitinous plate. Post-oral process stout and flanged. Maxilliped slender, without special armature. Sternal fork very characteristic, with large semicircular base, limbs highly flattened and nearly circular.

Distal exopod segment of first leg with the claws successively increasing in size, spine-like seta smooth and claw-like, lower setae normal. First two claws of exopod of second leg subequal and strongly barbed, third small and naked, endopod segments externally pectinate. Basal claw of exopod of third leg short but stout, flanged. Fourth leg stout, four-segmented, with five claws, first four claws finger-shaped, with pectinate surface, fifth claw naked and spine-like, the customary row of spinules at the base of the claws forming elongated spiny laminae. Fifth leg a small lobe carrying three setae, sixth a single seta (may be the reverse since they are placed close together).

*Length.*—6.0 mm.

*Host.*—*Mugil* sp.

*Distribution.*—Muscat, India (Bombay), Australia.

*Type* in the British Museum (N.H).

*Remarks.*—The shape of the genital segment and the size of the abdomen, the extreme flattening of the limbs of the sternal fork and the shape of the claws of the fourth leg easily distinguish this species.

Alleging that the limbs of the sternal fork, unlike as described by Bassett-Smith, are wide and blunt, Rangnekar created *C. bombayensis* and Kabata apparently upheld the validity of this species. Bassett-Smith's description is faulty on certain points. The accompanying illustrations based on the type in the British Museum shows beyond any doubt that *C. bombayensis* is a synonym of *C. platytarsis.*

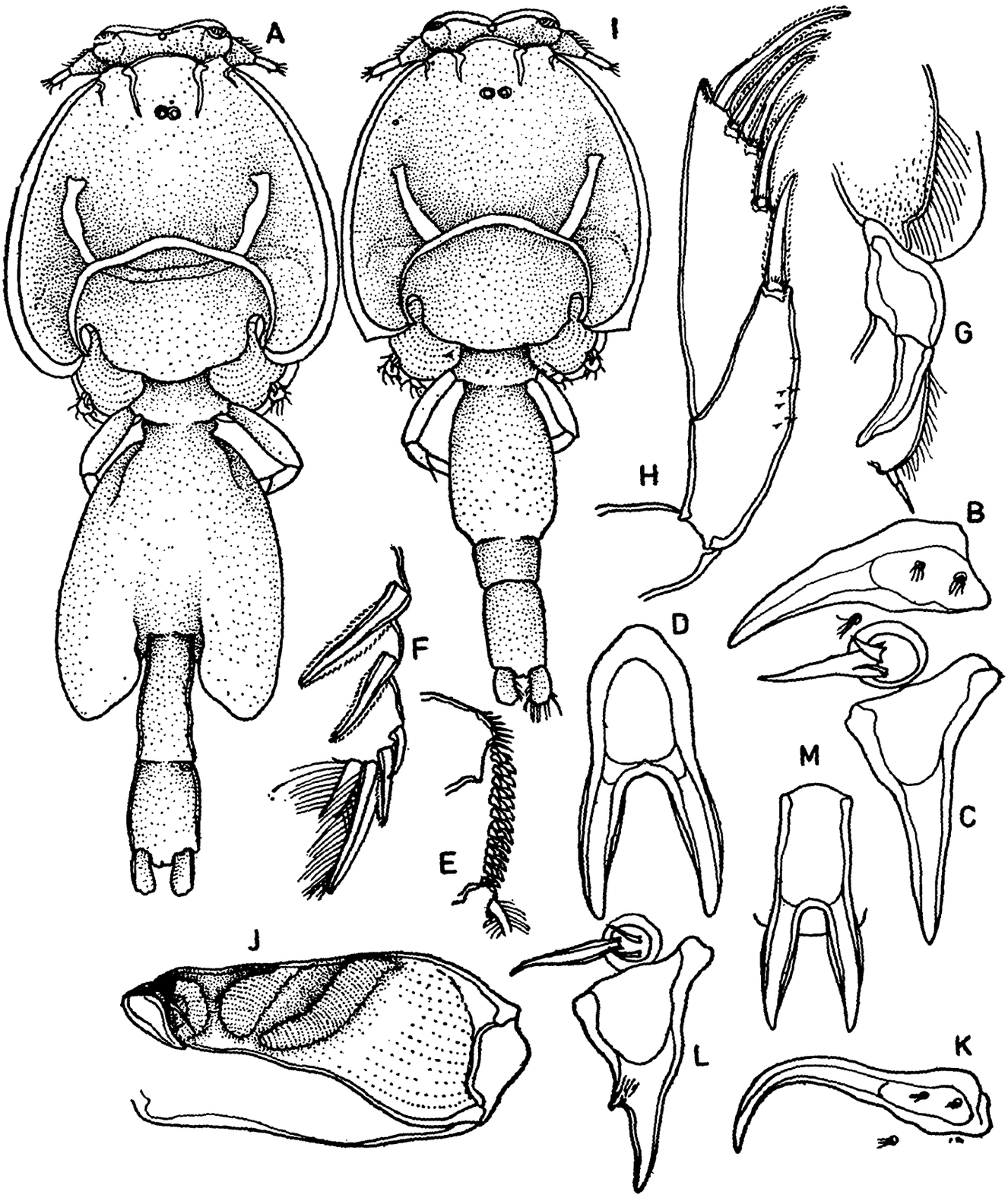


Fig. 114. *Caligus productus* Dana : A-H, Female. A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 2, endopod ; F, same, exopod ; G, leg 3, basal process of exopod ; H, leg 4, I-M, Male. 1, male, dorsal view ; J, antenna ; K, post-antennal process ; L, post-oral process and maxillule ; M, sternal fork.

second and third with accessory process. First two claws on exopod of second leg large and winged, third small, naked and curved. First segment of endopod with a short row of spines, second with two to three rows of teeth. Basal claw of exopod of third leg with stout base, claw characteristically curved. Fourth leg three-segmented, second segment with lower spines, claws strong, with narrow wings.

*Length.*—4.6 mm.

*Male.*—Membranous flange of cephalothorax postero-laterall-acute. Genital segment barrel-shaped. First segment of abdoment, much shorter than second. Post-antennal process a long, slender curved claw. Post-oral process with a small accessory process. Large seta of maxillule bulged beyond base. Second segment so antenna with three adhesion pads, third segment very short, with long seta. Sternal fork with slightly narrower rami.

*Length.*—3.6 mm.

*Host.—Thunnus pelamys, Coryphaena hippurus, Naucrates ductor, Neothunnus albacora, Scomberomorus cavalla, S. maculatus, S. sierra, Sarda sarda, Elops saurus, Pogonias cromis, Auxis thazard, Seriola dorsalis, Paralabrax clahratus, P. maculatofasciatus, Verrunculus polylepos, Katsuwonus vagans, K. pelamis, Sphyraena argentea, Calamus brachyomus, Euthynnus pelamis, E. affinis, Chrysophrys aurata.*

*Distribution.*—Widely distributed in tropical and subtropical waters of all oceans.

*Remarks.*—The single female and male in my collection show some difference from previous descriptions. They are only intra-specific variations.

## **Caligus quadratus** Shiino
(Fig. 115)

*Caligus quadratus* Shiino, 1954e, p. 26, figs. A-K ; 1959a,p. 1, figs.3-5 ; Yamaguti, 1963, p. 59, pl. 75, fig. 4 ; Lewis, 1967, p. 109, figs. 40-42; Pillai, 1967, p. 1976, fig. 36 ; Kabata and Gussev, 1966, p. 156, figs. 3-5 ; Margolis *et al.*, 1975, p. 66.

*Caligus productus* Wilson, 1905a, p. 597, pl. 14, figs. 162-170 (female only).
*Caligus monacanthi* Wilson, 1937, p. 424, figs. 7-19 (male only).
*Caligus coryphaenae* Yamaguti, 1936b, p. 5, pl. 4, figs. 40-54 (nec Stp. and Lutk. 1861).

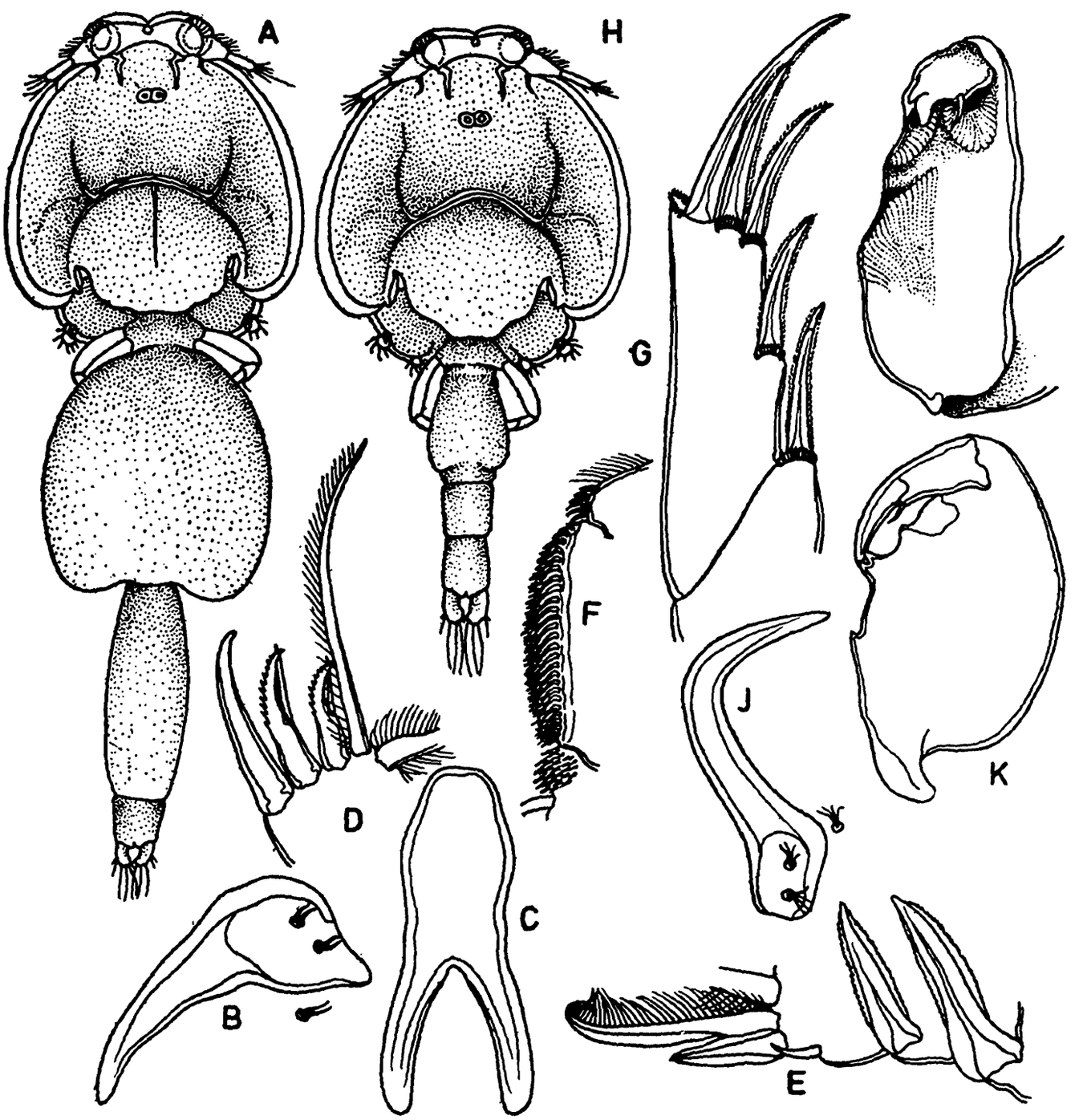


Fig. 115, *Caligus quadratus* Shiino : A-G. Female, A, female, dorsal view ; B, post-antennal process ; C, sternal fork ; D, leg 1 ; E, leg 2, exopod ; F, same, endopod ; G, leg 4, H-K, Male. H, male, dorsal view ; I, antennal ; J, post-antennal process ; J, maxilliped.

*Female.*—Cephalothorax pefectly rounded, frontal plates deep and projecting, lunules large. Postero-median lobe about three times as broad as lateral lobes, slightly overreaching latter. Fourth segment fused with genital segment, latter enlarged, more than three-fourths as broad as cephalothorax. Abdomen two-jointed, rather swollen, second segment very short.

Post-antennal process with broad base, claw slightly curved. Post-oral process elongate triangular. One of the setae of maxillule very stout, others very small. Maxilla and maxilliped normal. Sternal fork with long base, rami short and diverging, apices rounded.

Distal exopod segment of first leg with the usual armature, setae long, spine-like seta very long and hairy on upper side, claws gracefully curved, first smooth, second and third dorsally serrated and with accessory process. First two claws on exopod of second leg stout, with serrate wings, third slender, short, smooth and curved, basal segment of endopod partly hairy and partly spiny, second and third segments with a patch of spinules. Fourth leg three-segmented, claws progressively increasing in length.

*Length.*—6.0 mm.

*Male.*—Postero-median lobe of cephalothorax narrower, genital segment pear-shaped, abdomen two-segmented, segments subequal. Antenna modified, second segment with three adhesion pads, third segment short but broad and trifid. Post-antennal process long, slender and curved. Basal segment of maxilliped with two low processes and a high bifid process between them, second segment short but stout.

*Length.*—4.0 mm.

*Host.—Neothunnus macropterus, N. albacora, Histiophorus orientalis, Coryphaena hippurus, Rhinobatos schlegelii, Parathunnus macropterus.*

*Distribution.*—Tropical parts of all oceans.

## **Caligus raniceps** Heegaard

*Caligus raniceps* Heegaard, 1943b, p. 9, figs. 13-20 ; Yamaguti, 1963, p. 59, pl. 70, fig. 1 ; Margolis *et al.*, 1975, p. 67.

*Host.*—Unknown.

*Distribution.*—Bay of Bengal.

*Remarks.*—Though Heegaard was aware of its close resemblance to C. *curtus* Muller, he described the three males collected from an unknown host as a new species. His justification was that its antenna is one-segmented and that the genital segment in *C. raniceps* has two pairs of rudimentary leg papillae which reach the frontal part of the abdomen. In the light of the exhaustive description of *C. curtus* by Parker *et al.* (1968) it is almost certain that Heegaard's males belong to *C. curtus.*

Kirtisinghe (1964) recorded both males and females of *C. curtus* from Ceylon but Parker *et al.* discussing the distribution of *C. curtus* observed that this record is doubtful as it falls outside the known distributional areas and that Kirtisinghe's illustrations show that his specimens do not belong to *C. curtus.* Kirtisinghe's figures are some times not very accurate but in the present case they do resemble those of *C. curtus.* Unfortunately he did not give details regarding his material. Even conceding that Kirtisinghe's record is wrong what about Heegaards ? His specimens are apparently the males of *C. curtus.* Probably there has been some confusion in the labels regarding the collection locality.

According to Parker *et al.*, (1968) *C. curtus* is a North Atlantic species. Its inclusion in the present work is therefore, provisional.

## **Caligus robustus** Bassett-Smith
(Fig. 116)

*Caligus robustus* Bassett-Smith, 1998c, p. 351, pl. 2, figs. 1-2 ; Wilson, 1905a, p. 497 ; 1913, p. 212, pl. 28, figs. 81-91 ; Pillai, 1963f, p. 73, fig. 4; Yamaguti, 1963, p. 59, pl. 81, fig. 2 ; Kirtisinghe, 1964, p. 55, figs. 29-30 ; Margolis *et al.*, 1975, p. 71.

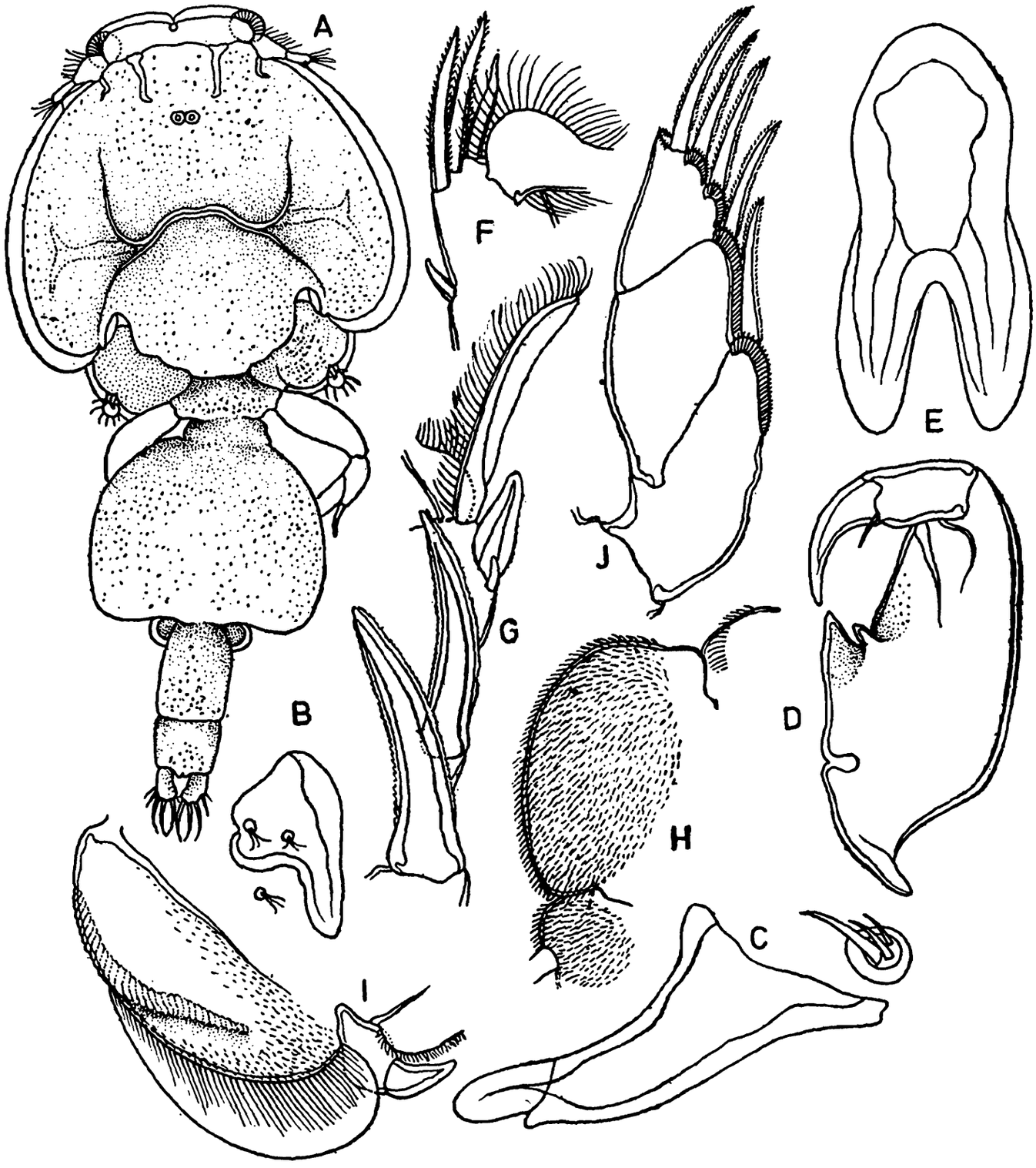


Fig. 116, *Caligus robustus* Bassett-Smith : A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, maxilliped ; E, sternal fork ; F, leg 1 ; G, leg 2, exopod ; H, same, endopod ; I, leg 3 ; J, leg 4.

*Female.*—Cephalothorax regularly broadening backwards, broader than long, frontal plates moderately deep, postero-median

lobe twice as broad as lateral lobes, posterior sinuses shallow and wide open. Genital segment hemispherical, half as broad as cephalothorax. Abdomen two-segmented, nearly as long as genital segment. Caudal rami oblong, with short setae.

Post-antennal process a small triangular plate with blunt claw. Post-oral process large, claw with a partition and a small accessory process. Maxilliped stout, basal segment with a large process and a smaller one just in front. Sternal fork with strongly flattened, apically rounded nearly parallel limbs.

Vestigial endopod of first leg with two spines, setae on distal exopod segment stout, first claw naked, small and placed away from second, second and third claws like the spine-like seta, with marginal spinules. First two claws on exopod of second leg large, curved and subequal, with narrow serrate wings, third claw very small and naked, first segment of endopod with a row and second and third with a patch of spinules. Basal claw of exopod of third leg short. Fourth leg four-segmented, broad, with long spiny crests at the base of the claws.

*Length.*—5.4 mm.

*Male.*—Genital segment small, with median constriction and distal projection carrying the vestigial legs. First segment of abdomen very short. Antenna modified but slender, second segment with one adhesion pad, third basally swollen, with moderately large accessory claw and spine-like seta.

*Length.*—3.1 mm.

*Host.—Megalaspis cordyla, Bathystoma rematar, Caranx hippos, C. sansun, C. melaampygus, Paratractos crysos, Neothunnus macropterus, Selar mate, Atule djedaba.*

*Distribution.*—India (Kerala), Sri Lanka, Aden, Jamaica, Mexico, Mauritania.

*Remarks.*—This species shows considerable variation in size depending on the size of the host.

## **Caligus rotundigenitalis** Yu
(Fig. 117)

*Caligus rotundigenitalis* Yu, 1933, p. 117, pl. 1, figs. 1-7 ; pl. 2, figs. 1-4 ; Rangnekar, 1959, p. 43, fig. 1 ; Yamaguti, 1963, p. 59, pl. 77, fig. 2 ; Margolis *et al.*, 1975, p. 71 ; Pillai and Natrajan, 1977, p. 31, figs. 55-66.

*Female.*—Cephalothorax with evenly curved sides, frontal plates deep but not projecting, postero-median lobe twice as broad as lateral lobes and projecting, posterior sinuses shallow, partially closed. Fourth segment short but broad. Genital segment large and swollen, roughly semicircular, abdomen two-segmented, first segment slightly enlarged. Caudal rami oblong, with six setae.

Antenna rather slender, with small basal process, distal segment strong. Post-antennal process very small. Post-oral slender, reaching beyond the oral cone, with very small accessory process. Distal segment of maxilla longer than basal, claws short. Maxilliped slender, basal segment with small proximal inner spine. Sternal fork with short base, limbs bracket-shaped, strongly flattened.

Vestigial endopod of first leg flattened, with apical spinule, distal exopod segment with the claws similar to the spine-like seta, latter naked, first claw rather small. First two claws of exopod of second leg large, winged, third small, naked, second and third endopod segments broad, with large patch of spinules. Fourth leg four-segmented, basal segment broad, second segment with an inner spinule, last claw bilaterally pectinate, others fully covered with stiff spinules the patch of spinules at the base of the claws projecting as prominent processes.

*Length.*—2.9 mm.

*Host.—Lutianus malabaricus, Caranx specious, Scatophagus argus.*

*Distribution.*—China, India (Bombay, Kerala).

*Remarks.*—Only Yu and Rangnekar have described this species. Both have shown the genital segment as circular. The genital segment gradually widens backwards and resembles that of *C. laticaudus*

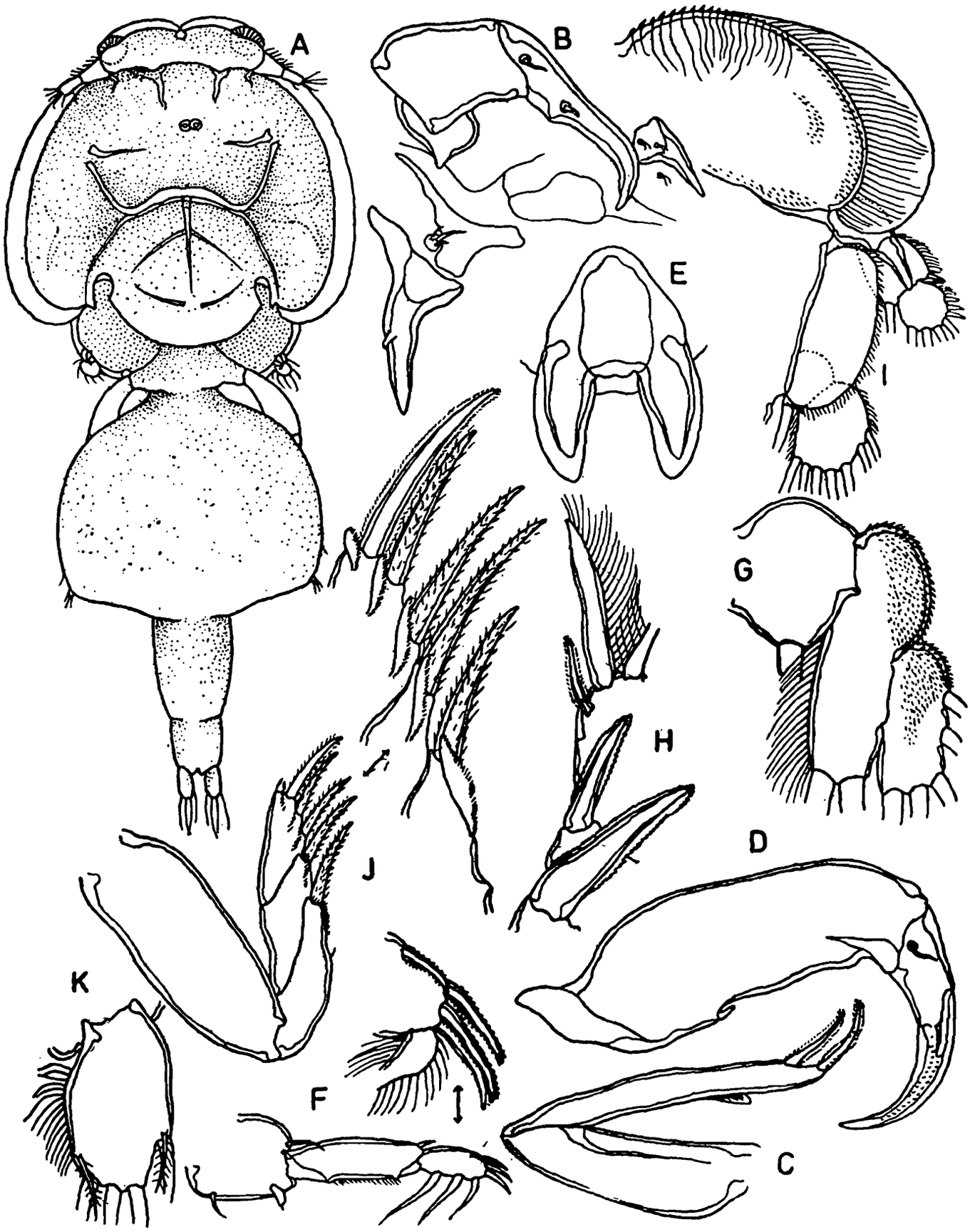


Fig. 117. *Caligus rotundigenitalis* Yu : A, female, dorsal view ; B, antenna, post-antennal process and post-oral process ; C, maxilla; D, maxilliped ; E, sternal fork ; F, leg 1 ; G, leg 2, endopod ; H, same, exopod ; I, leg 3 ; J, leg 4 ; K, caudal ramus.

Shiino. The first abdominal segment is rather swollen and the basal segment of the maxilliped has a small inner process which has not been shown earlier. The sternal fork is as shown by Rangnekar. The claws on the distal segment of leg one are like the spine-like seta. These have not been correctly illustrated so far. The distal claw of leg four hitherto shown as naked is bilaterally pectinate.

## Caligus russellii Kurian
(Fig. 118-119)

*Caligus pterois* Kurian, 1949, p. 193 ; Margolis *et al.*, 1875, p. 65.
*Caligus russellii* Kurian, 1950, p. 1, pls. 1-3 ; 1955, p. 103 ; Pillai, 1963f, p. 79, fig. 8 ; Margolis *et al.*, 1975, p. 72.

*Female.*—Cephalothorax nearly circular, frontal plates low but projecting due to the prolongation of the antero-median part of the cephalothorax. Lunules small and inconspicuous. Median lobe very broad, about four times as broad as lateral lobes and clearly projecting, its distal border rounded. Posterior sinuses shallow and open. Fourth segment very short. Genital segment broadening backwards, swollen, half the length of cephalothorax. Abdomen short, one-segmented and rather stout. Caudal rami large, longer than broad.

Post-antennal process a stout distally curved claw with long and broad base. Post-oral process with broad base, distal part narrow. Basal segment of maxilliped with inner median projection, distal segment long, stout and curved. Sternal fork with broad base, rami slightly diverging, winged and apically acute, placed wide apart, producing a very characteristic shape.

Distal segment of first leg with three large setae, spine-like seta exceptionally long, first claw smooth, second and third dorsally serrated, with slender accessory process. First claw of exopod of second leg very stout, third exceptionally small, first seta a short flattened winged lobe, second with broad dorsal wing. Fourth leg three-segmented, slender, last claw very long, about two and a half times as long as the penultimate.

*Length.*—5.8 mm.

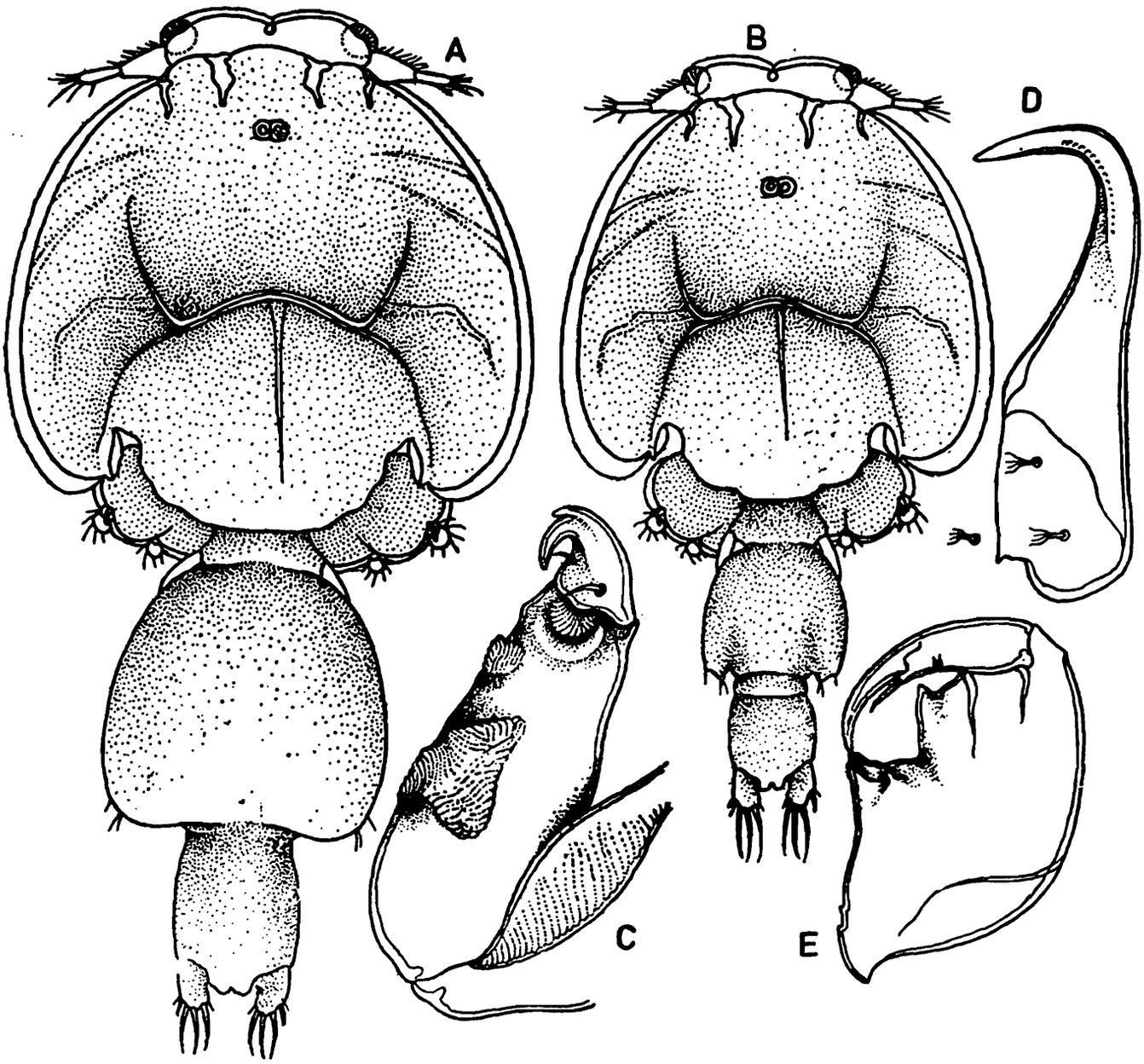


Fig. 118. *Caligus russellii* Kurian : A, female, dorsal view. B-E, Male. B, male dorsal view ; C, antenna ; D, post-antennal process ; E, maxilliped.

*Male.*—Frontal plates of cephalothorax less projecting, median lobe only twice as broad as lateral lobes. Fourth segment longer. Genital segment small, slightly longer than broad. Post-antennal process with longer base, claw stouter and more curved. Antenna modified, basal segment with one adhesion pad, second segment very large, with three adhesion pads, third segment short, with swollen base, with accessory process. Maxilliped stouter, basal segment with a high bifid prominence carrying a rounded projection

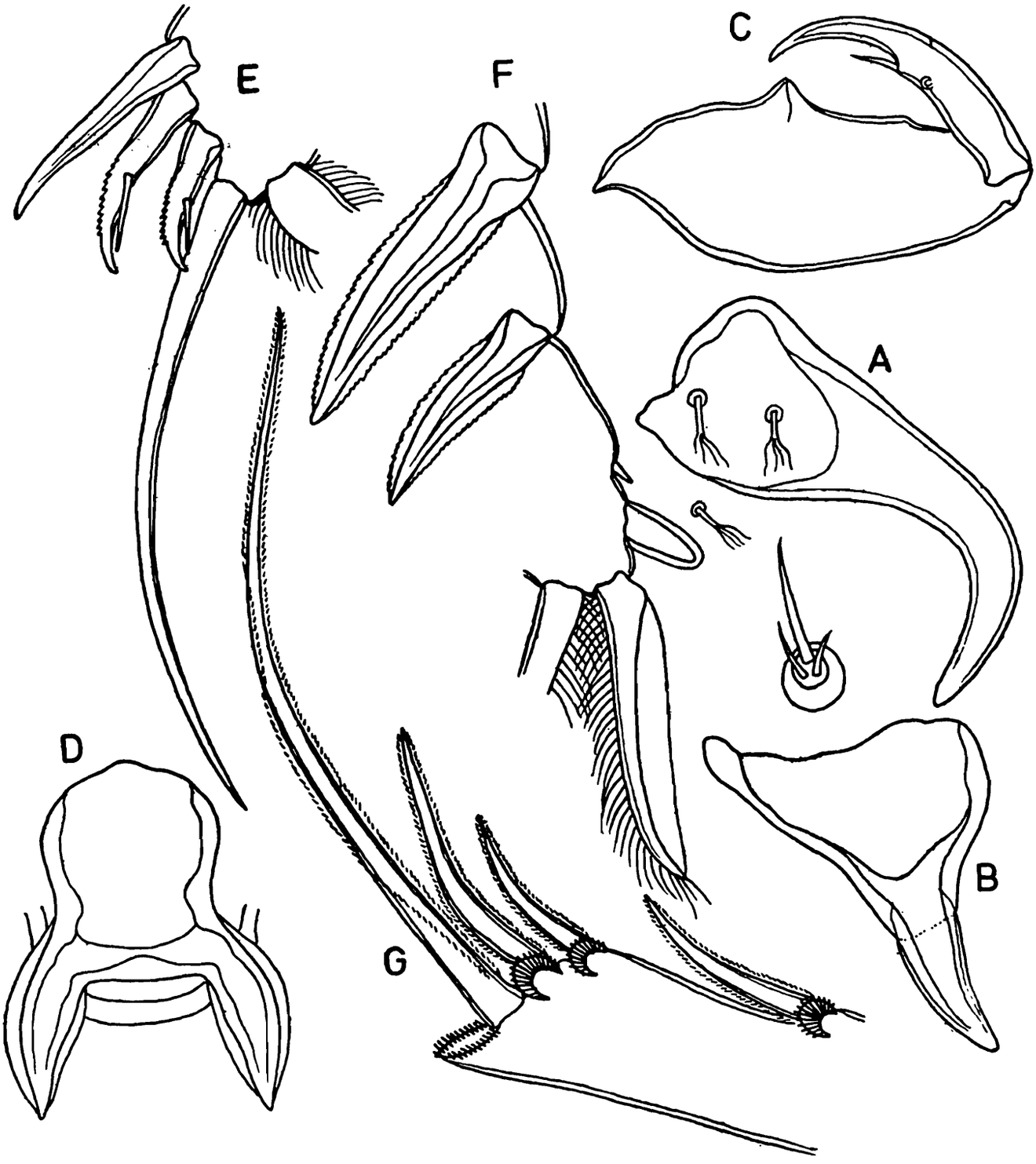


Fig. 119. *Caligus russellii* (contd.) : Female. A, post-antennal process ; B, post-oral process and maxillule ; C, maxilliped ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, leg 4.

on its base and a distal process, distal segment with a long straight spine.

*Length.*—4.4 mm.

*Host.*—*Pterois russellii, P. miles.*

*Distribution.*—India (Kerala).

*Remarks.*—The post-antennal process, sternal fork and the armature of legs one, two and four provide unique characters easily distinguishing this species.

In a preliminary description Kurian (1949) described this species as *C. pteroisi.* But in the more detailed description it was described as *C. russellii.* Hence the specific name should be *C. pteroisi.* But it is doubtful whether the earlier description is adequate.

**Caligus savala** Gnanamuthu
(Fig. 120)

*Caligus savala* Gnanamuthu, 1948a, p. 591, figs. 1-8 ; Yamaguti, 1963, p. 60 ; Pillai, 1969, p. 164, figs. 81-101 ; Margolis *et al.*, 1975, p. 73.
*Caligus cunicephalus* Gnanamuthu, 1950b, p. 113, figs. 1-16.
*Caligus affinis* Kurian, 1961, p. 71, figs. 37-45.
*Caligus acutus* Kirtisinghe, 1964, p. 66, figs. 58-67 ; Pillai, 1967d, p. 1588, fig. 63.

*Female.*—Cephalothorax roughly triangular, membranous flange postero-laterally acutely produced, postero-median lobe very broad and evenly convex, about four times as broad as lateral lobes, posterior sinuses shallow. Genital segment small. Abdomen one-segmented, as long as genital segment, rather stout. Caudal rami-with long setae.

Basal segment of antennule with long bushy setae, last seta reaching the tip of second segment. Post-antennal process with small base, claw slender. Post-oral process elongate-triangular, slightly curved. Basal segment of antenna produced into a long process. Maxilliped slender. Sternal fork with rami narrowing distalwards and slightly diverging.

Distal segment of first leg with very large setae, spine-like seta very long and curved, first claw very short, others long, with accessory process. First claw of exopod of second leg stout, second straight and smaller, both with narrow serrate wings, third claw

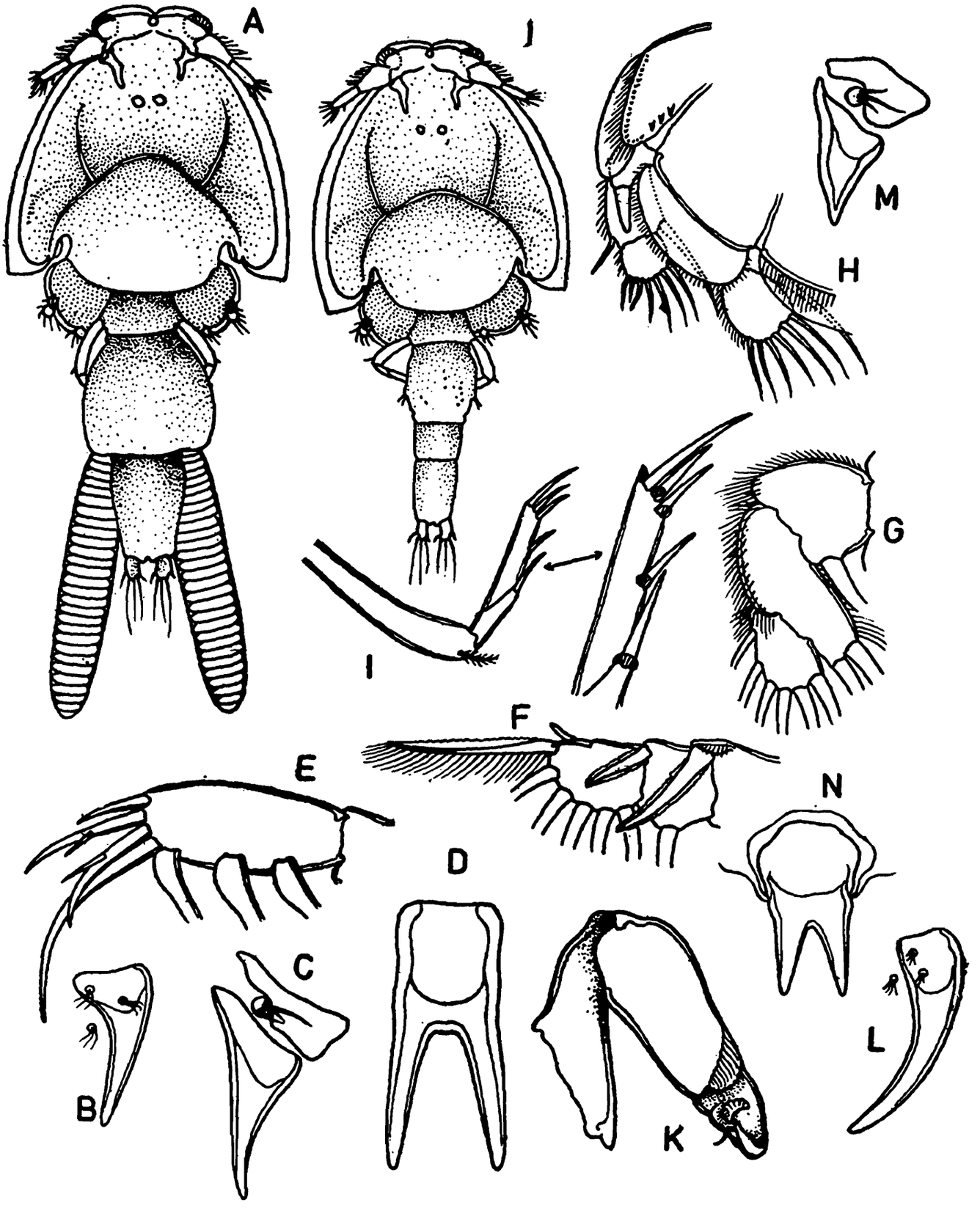


Fig. 120. *Caligus savala* Gnanamuthu : A-1, Female. A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 3 ; I, leg 4. J-N, Male. J, male, dorsal view ; K, antenna ; L, post-antennal process ; M, post-oral process and maxillule ; N, sternal fork.

a small naked spine, first seta like the third claw but blunt, segments of endopod hairy. Rami of third leg placed wide apart, basal claw of exopod straight. Fourth leg slender, three-segmented, last claw one and a half times as long as the penultimate.

*Length.*—4.0 mm.

*Male.*—Genital segment small, with median lateral constriction housing the vestigial legs. Abdomen two-segmented. Second Segment of antenna with two adhesion pads, third short, strongly curved. Post-oral process small, triangular. Basal segment of maxilliped robust, with a low conical process.

*Length.*—3.5 mm.

*Host.—Euthynnus affinis, Gaterin lineatus, Trichiurus haumela T savala.*

*Distribution.*—India (Kerala, Madras), Sri Lanka.

*Holotype.*—Male in the Indian Museum, cotypes, females and male in the British Museum (N. H.)

*Remarks.*—The original description of this species by Gnanamuthu contained very little morphological information. This probably made Kurian describe a female from *Euthynnus affinis* as *C. affinis*. As this name was preoccupied Kirtisinghe renamed it as *C. acutus*. I examined two females and one male (cotypes) of *C. savala* in the British Museum and was surprised to find that it is the same as *C. acutus* (Kurian).

During the course of the present work I was able to study the allotype male of *C. cunicephalus* Gnanamuthu. This male corresponds exactly with the male of *C. savala* in the British Museum even in minute details.

### **Caligus Sciaenae** Gnanamuthu

*Caligus sciaenae* Gnanamuthu, 1947d, p. 43, figs. 1-12 ; Yamaguti, 1963, p. 60 ; Pillai, 1967d, p. 1590, fig. 70 ; Margolis *et al.*, 1975, p. 74.

*Host.*—*Sciaena glaucus.*

*Distribution.*—India (Madras).

*Remarks.*—Gnanamuthu has described this species with all sorts of unusual characters. Its cephalothorax is nearly circular, the posterior half with about six dorsal ribs pointing in various directions. Behind the cephalothorax is shown a segment carrying the fourth legs. But in front of the genital segment and behind the fourth there is another segment. The caudal rami are two segmented.

From his description the following characters may be deduced. Cephalothorax nearly circular, postero-median lobe completely overlapping fourth segment. Genital segment nearly twice as broad as succeeding segment and four times as long, first abdominal segment broader than long. Third leg biramous, natatory, with three-segmented normal rami, fourth leg three-segmented, fifth leg long and four-segmented.

*Length.*—1.7 mm.

No specimen of this species exists and if it cannot be redescribed this species will have to be discarded.

## **Caligus tenax** Heller
(Fig. 121)

*Caligus tenax* Heller, 1868, p. 172, pl. 15, fig. 3 ; Bassett-Smith, 1898c, p. 363, pl. 11, fig. 3 ; Wilson, 1913, p. 208, pl. 26, figs. 99-101 ; Kirtisinghe, 1937a, p. 437, figs. 15-29 ; 1964, p. 67 figs. 68-69 ; Yamaguti, 1963, p. 61, pl. 77, fig. 3, pl. 79, fig. 6.

*Female.*—Cephalothorax with very deep projecting frontal plates, postero-median lobe about one and a half times as broad as lateral lobes, latter curving inwards and overlapping median lobe closing the posterior sinuses. Fourth segment as long as broad. Genital segment large, with distinct anterior neck. Abdomen more than twice as long as broad, one-segmented, with median constriction. Caudal rami small, sunk into abdomen.

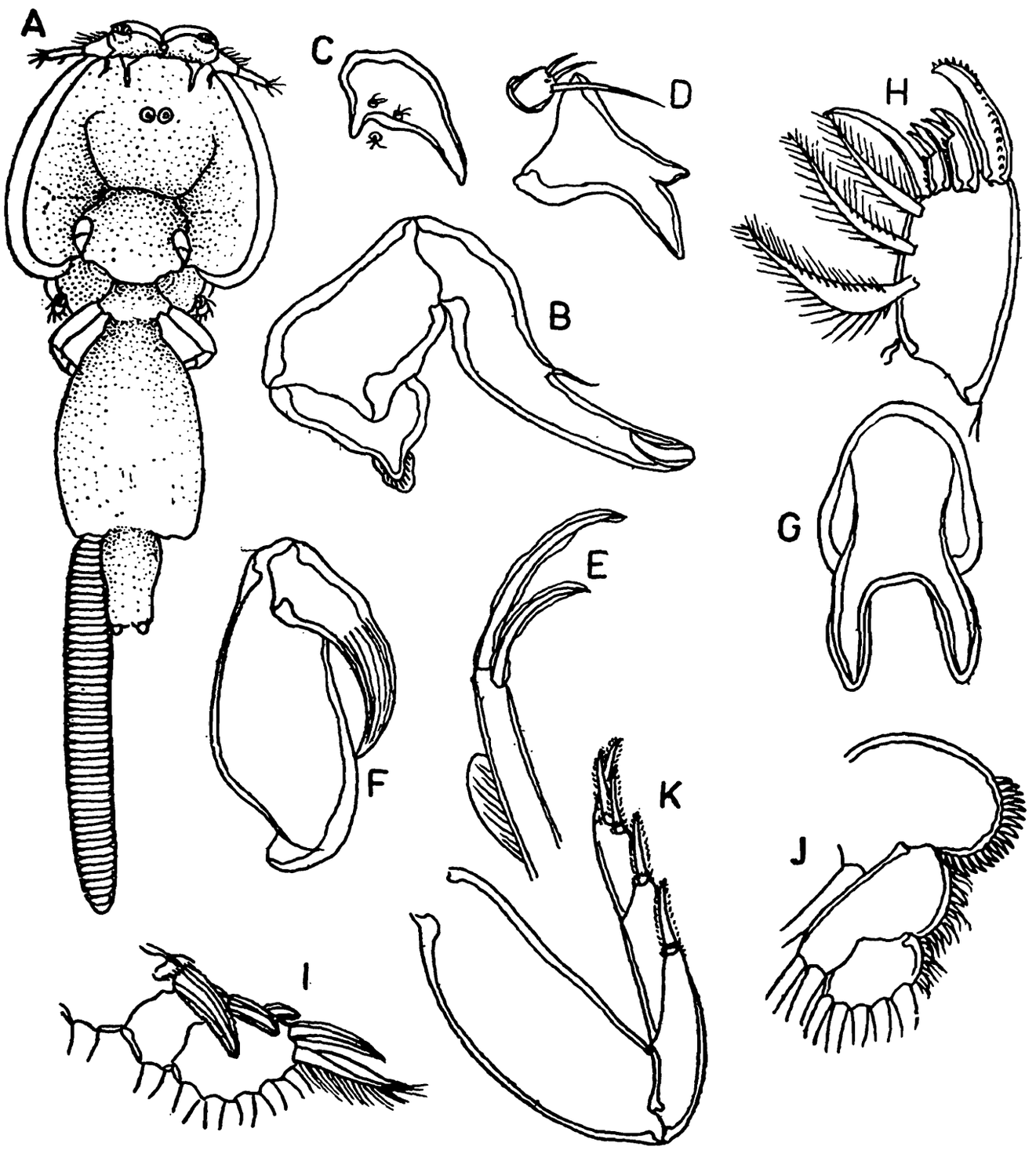


Fig. 121. *Caligus tenax* Heller : A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilla ; F, maxilliped; G, sternal fork; H, leg 1;I, leg 2, exopod; J, same, endopod; K, leg 4.

Distal segment of antennule long. Basal segment of antenna with blunt process, distal long. Post-antennal process with sharp accessory process on base. Post-oral process with accessory process.

Sternal fork with indistinct base, limbs diverging and curving inwards.

Distal segment of first leg with stout claws decreasing in length, second and third with subsidiary process, spine-like seta stout, naked and as long as the first ventral seta. Claws on exopod of second leg decreasing in size, with serrate wings, basal segment of endopod large, with a row of teeth, other segments hairy. Apron of third leg with a patch of large teeth, basal claw of exopod strongly curved. Fourth leg four-segmented.

*Length.*—4.5 mm.

*Male.*—Genital segment together with the short abdomen roughly oval in shape. Antenna and post-antennal process modified.

*Length.*—3.0 mm.

*Host.*—*Caranx hippos, S. crysos.*

*Distribution.*—Brazil, West Indies, Sri Lanka.

## **Caligus tylosuri** (Rangnekar)

(Fig. 122)

*Tuxophorus tylosuri* Rangnekar, 1956, p. 52.
*Caligus tylosuri* Pillai, 1961, p. 96, fig. 6 ; 1966, p. 132, fig. 6 ; Cressey and Collette, 1970, p. 347, figs. 113-116 ; Margolis *et al.*, 1975, p. 81

*Female.*—Cephalothorax comparatively very large, frontal plates low. Postero-median lobe slightly projecting, about twice as broad as lateral lobes, posterior sinuses shallow and partially closed. Fourth thoracic segment small, forming rounded lobes at the base of the legs. Genital segment swollen. broader than long. Abdomen very short, one-segmented, more or less fused with genital segment, its outer distal part spiny.

Basal segment of antenna with small process. Post-antennal process small, post-oral triangular. Claws of maxilla long, with

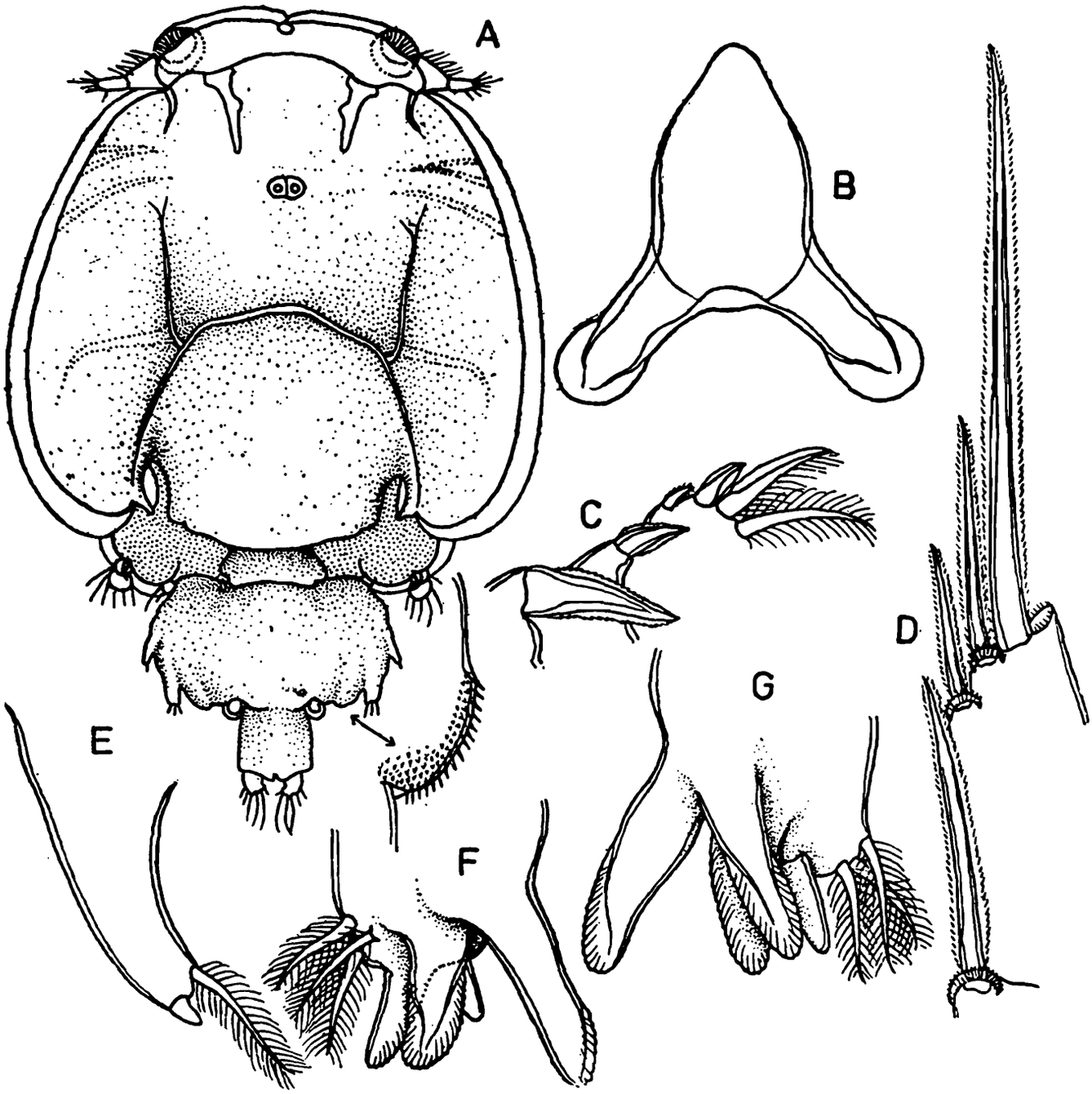


Fig. 122. *Caligus tylosuri* (Rangnekar) : A, female, dorsal view : B, sternal fork; C, leg 2, exopod ; D, leg 4 ; E, leg 5 ; F-G, leg 6.

broad wings. Sternal fork with large conical base, rami strongly diverging, short and apically enlarged into circular lobes.

Distal segment of first leg with short spiny claws, second and third with accessory process, spine-like seta small and naked. Claws on exopod of second leg successively decreasing in size. Fourth leg slender, three-segmented and irregular in shape, second

segment with a winged claw, nearly reaching the tip of the third segment, distal claw of third segment stout, long and straight, more than twice as long as the penultimate. Fifth leg a prominent process with a tooth and a seta. Sixth leg a stout process carrying four processes with bluntly serrate borders and three plumose setae.

*Length.*—4.4 mm.

*Male.*—Cephalothorax more linear, genital segment somewhat rounded, with median constriction. Abdomen triangular, two-segmented. Caudal rami with long setae.

*Length.*—3.2 mm.

*Host.—Tylosurus crocodilus, T acus melanotus, T acus pacificus, Chorinemus lysan.*

*Distribution.*—India (Bombay, Kerala), Philippines, Borneo, Japan, Gulf of California.

*Remarks.*—Cressey and Collette observed that the two lateral processes on the genital segment represent the exopod and endopod of the fifth leg and that the sixth leg is represented by two setae close to the base of the abdomen. In the light of this observation many descriptions of caligids will have to be modified. An identical condition exists in *C. savala* male.

From *Chorinemus lysan* I collected *Tuxophorus caligodes, Lepeophtheirus spinifer* and *Caligus tylosuri.* The cephalothorax of all the three species shows a surprising similarity. This, as stated earlier, appears to be another instance of adaptive convergence induced by the surface characteristics of the host.

## **Caligus undulatus** Shen and Li
## (Fig. 123)

*Caligus undulatus* Shen and Li, 1959, p. 16, pl. 1, figs. 1-16 ; Yamaguti, 1963, p. 61, pl. 80, fig. 3 ; Pillai, 1966, p. 123, fig. 1 ; Margolis *et al.*, 1975, p. 81.

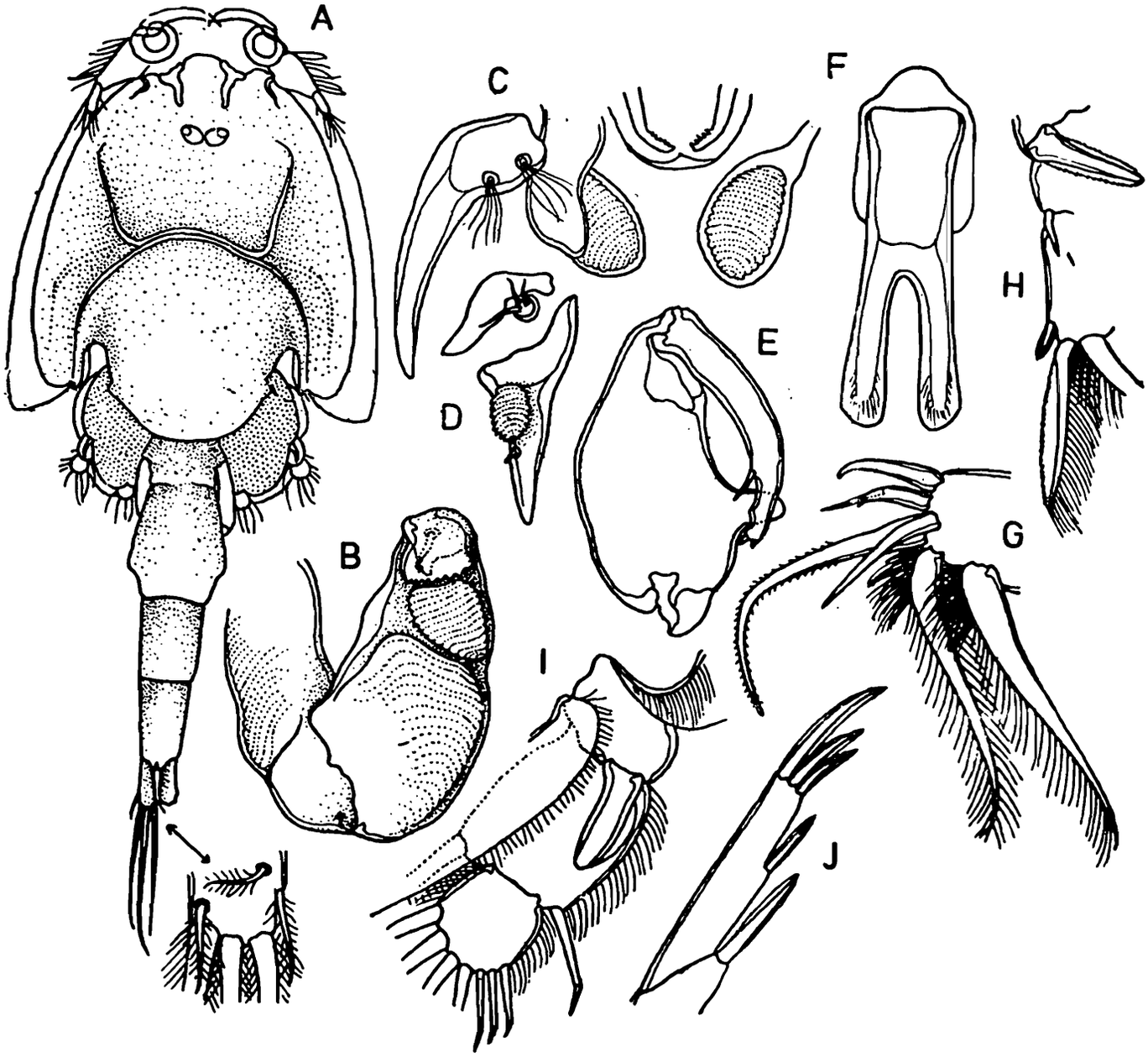


Fig. 123. *Caligus undulatus* Shen and Li : A, male, dorsal view ; B, antenna ; C, post-antennal process and post-oral pads ; D, post-oral process and maxillule ; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, leg 3 ; J, leg 4.

*Male.*—Cephalothorax triangular, frontal plates deep but not projecting. Postero-median lobe about three times as broad as lateral lobes, prominently projecting, posterior sinuses wide open. Membranous flange postero-laterally angular. Fourth segment squarish, genital segment longer than broad. Abdomen two-jointed, segments subequal in length. Caudal rami about three times as long as broad, with very long setae.

Antennule stout, basal segment with several rows of setae, marginal setae long. Antenna modified, basal segment long, with an adhesion pad, second segment with two adhesion pads, third short but broad, spatulate, its distal border serrate. Post-antennal process stout. Post-oral process with an adhesion pad and a spine. A pair of pads just behind the oral cone. Maxilliped stout, basal segment with a high smooth projection, distal segment with sub-parallel borders, apex with two small teeth. Sternal fork with narrow base, limbs diverging, apically flattended and rounded.

Distal exopod segment of first leg with three unusually long heavily plumose setae, spine-like seta long, stout and spinulose, first claw strongly curved, second with long accessory process, third longest, smooth and bent near base. First claw of exopod of second leg stout and blunt, second very small, third absent, first seta very small, second with normal modification. Basal claw of exopod of third leg of uniform width, apex broadly rounded, outer side winged. Fourth leg slender, three-jointed.

*Length.*—3.5 mm.

*Female.*—Cephalothorax similar to that of male, postero-median lobe broader and more rounded. Fourth segment indistinct, genital segment transversely wrinkled ? Abdomen one-jointed, caudal rami long, with long setae. (Description from Shen and Li).

*Host.*—Free living.

*Distribution.*—China, India (Palk Bay).

*Remarks.*—My collection contains only a single male and hence the description of the female is after Shen and Li. It is likely that the description of the fourth and genital segments of the female by Shen and Li is incorrect. In the figure of the male they have shown two segments between the cephalothorax and the genital segment. This species has several very diagnostic characters.

### **Caligus unguidentatus** Rangnekar and Murti
(Fig. 124)

*Caligus unguidentatus* Rangnekar and Murti, 1950a, p. 21, pl. 1, figs. 1-13 ; Yamaguti, 1963, p. 61 ; Margolis *et al.*, 1975, p. 82.

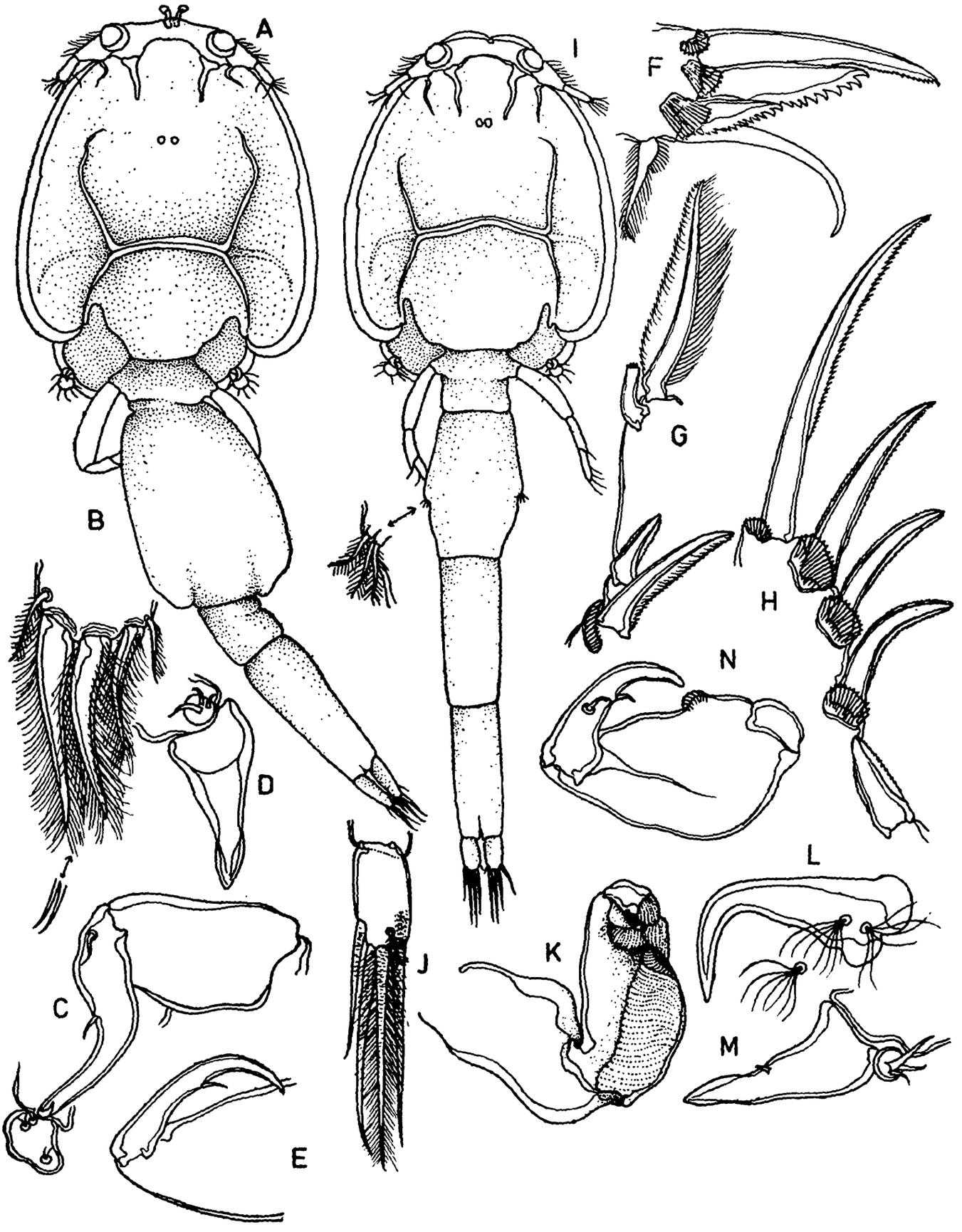


Fig. 124. *Caligus unguidentatus* Redkar et al. : A-H, Female. A, female, dorsal view ; B, caudal ramus ; C, antenna and post-antennal process ; D, post-oral process and maxillule ; E, maxilliped ; F, leg 1 ; G, leg 2, exopod ; H, leg 4. I-N, Male. I, male, dorsal view ; J, caudal ramus ; K, antenna ; L, post-antennal process ; M, post-oral process and maxillule ; N, maxilliped.

*Caligus hilsae* Shen, 1957b, p. 351, pl. 7, figs. 86-97 ; Yamaguti, 1963, p. 54, pl. 65, fig. 4 ; Pillai and Lal Mohan, 1967, p. 45 figs. 1-9 ; Margolis *et al.*, 1975, p. 37.

*Female.*—Cephalothorax longer than broad, with low projecting frontal plates, postero-median lobe broader than lateral lobes, clearly projectings, its distal border truncate. Fourth segment large. Genital segment broadening backwards, with very short anterior neck. Abdomen two-segmented, second segment longer, narrowing. Caudal rami large, narrowing, with stout flattened setae armed with spinules rather than hairs.

Distal segment of antennule comparatively long. Basal segment of antenna without process, distal long and slender. Post-antennal process a simple plate, post-oral apically flattened. Maxilliped with very stout basal segment and strongly curved distal segment. Sternal fork absent.

Distal segment of first leg with well developed setae, proximally spiny, spine-like seta long and stout, naked, first claw long, with feebly barbed ventral wing, second and third highly flattened, with serrate ventral wing. First claw of exopod of second leg with ventral flange, second smaller than first, third absent, first seta curved and apically dentate, second with serrate upper wing, endopod segments with patches of stiff setules. Basal claw of exopod of third leg short and flattened. Fourth leg three-segmented, last claw much longer than the penultimate.

*Length.*—8.2 mm.

*Male.*—Fourth thoracic segment long. Genital segment elliptic. Abdomen exceptionally long, two-segmented, segments subsimilar, with dorso-median carina. Caudal rami rectangular, with long bushy setae.

Antenna with three adhesion pads on second segment, third segment short and flattened, with corrugated rounded distal part. Post-antennal process a stout curved claw, post-oral with a small accessory process. Maxilliped more massive than in female, basal segment with a projection, with crenate border, distal segment stouter than in female.

*Length.*—10.4 mm.

*Host.—Hilsa reeversi, H. toli.*

*Distribution.*—China, India (Bombay, Kutch).

*Remarks.*—The present specimens show some difference from previous descriptions. However, as this species has many unusual characters the identity of the present specimens need not be doubted.

## **Caligus uruguayensis** Thomsen
(Fig. 125)

*Caligus uruguayensis* Thomsen, 1949, p. 3, pls. 2-3 ; Yamaguti, 1963, p. 62 pl. 75, fig. 1 ;
*Caligus longicervicis* Gnanamuthu, 1950b, p. 115, figs. 31-46 ; Yamaguti, 1963, P. 55, pl. 63, fig. 3 ; Kirtisinghe, 1964, p. 65, fig. 51 ; Margolis *et al.*, 1975, p. 48.
*Caligus cunicephalus* Pillai, 1963f, p. 77, fig. 7 (nee Gnanamuthu 1950f).

*Female.*—Cephalothorax gradually widening backwards, postero-median lobe only moderately broader than lateral lobes and only slightly projecting. Fourth segment nearly equal in length and width. Genital segment swollen, nearly as long as cephalothorax but narrower. Abdomen one-segmented, narrowing. Caudal rami long, with long setae.

Basal segment of antenna with a small process. Post-antennal process very small, a traingular plate. Post-oral process triangular, nearly straight. Maxilla short, with short but stout distal claws. Basal segment of maxilliped stout, distal short. Sternal fork absent.

First leg short but deep, distal segment with three short setae, spine-like seta very long and naked, claws greatly unequal in length, first twice as long as third, with broad ventral serrate flange, second and third with similar flange on both sides, all claws with basal crest of spinules. First claw of exopod of second leg large and barbed on both sides, second unusually small, third absent, first seta small and winged on both sides, endopod segments with stiff spinules. Fourth leg long, three-segmented, first segment longer than rest of limb, claws short, last twice as long as the penultimate.

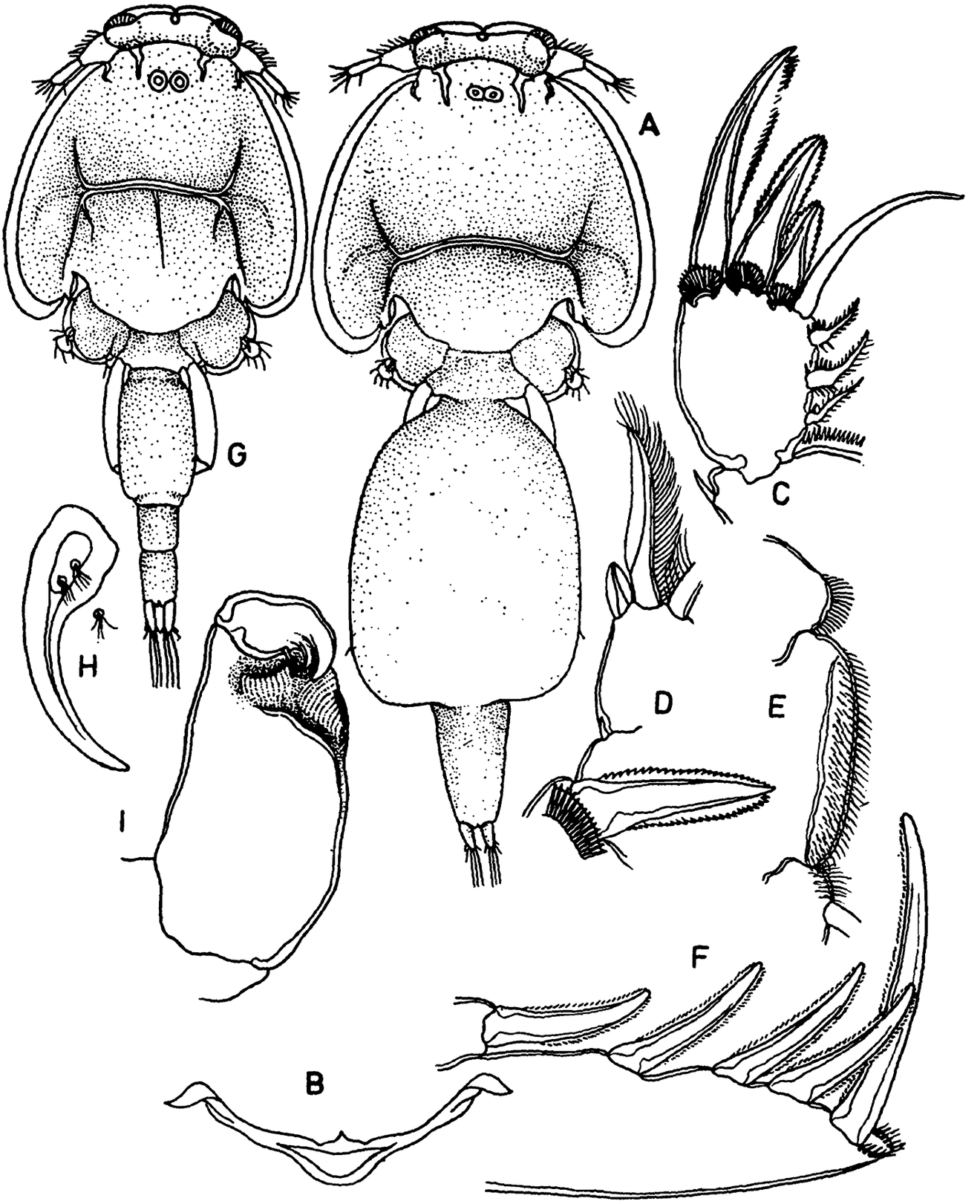


Fig. 125, *Caligus uruguayensis* Thomsen : A-F, Female. A, female, dorsal view ; B, intercoxal plate ; C, leg 1 ; D, leg 3, exopod ; E, same, endopod ; F, leg 3. G-I, Male. G, male, dorsal view ; H, post-antennal process; I, antenna.

*Length.*—4.9 mm.

*Male.*—Fourth segment comparatively large. Genital segment narrow and oblong. Abdomen two-segmented, segments subequal. Second segment of antenna with two adhesion pads, third short and broad, bifid. Post-antennal process well developed, a long curved claw, post-oral narrower than in female, with small accessory spine.

*Length.*—2.6 m

*Host.—Trichiurus lepturus, T haumela, T savala.*

*Distribution.*—Montevideo, India (Madras, Kerala), Sri Lanka.

*Remarks.*—This is a species with well marked characters. The absence of the sternal fork and the armature of legs one and two and the elongation of the fourth leg easily distinguish this species.

The specimens in my collection so closely resemble *C. uruguayensis* that there is no doubt that *C. cunicephalus* is a synonym of Thomsen's species. Both are parasites of *Trichiurus.*

Thomsen created subgenus *Metacaligus* to include species of *Caligus* without sternal fork. He has listed four species, *C. rufus* Wilson (1908a), *C. afurcatus* Wilson (1913), *C. enormis* Wilson (1913) and *C. uruguayensis* Thomsen (1949). To these must be added *C. unguidentatus* Rangnekar and Murti (1950a). It should be pointed out that the absence of the sternal fork is the only character which distinguishes these species from their congeners. Thomsen's suggestion deserves consideration though it apparently failed to get accepted.

## Genus **Pseudocaligus** Scott

*Pseuaocaligus*, Wilson, 1905a, p. 533; Yamaguti, 1963, p. 65; Kabata, 1965a p. 29 ; Cressey, 1967d, p. 4.

*Diagnosis.*—Very much similar to *Caligus.* Cephalothorax of varying shape and size, generally longer than broad. Lunules present. Genital segment enlarged, smaller than cephalothorax

(except in *P. laminatus*). Abdomen one-or-two-jointed (very short in *P. laminatus*). Post-antennal process small in female, large in male. Post-oral process small. Maxillule large and conical. Maxilla and maxilliped as in *Caligus*. Sternal fork present. Legs one to three as in *Caligus*, leg four reduced to a stump carrying one to three setae.

Male showing dimorphism as in *Caligus*.

Parasites of teleosts.

Type species : *P. brevipedis* (Bassett-Smitth).

*Discussion.*—Kabata (1965a) expressed the opinion that unless there are other valid differences it is not advisable to create genera based on the degeneration of the fourth leg. This is true because among caligids several genera like *Pseudocaligus*, *Pseudolepeophtheirus*, *Hermilius*, *Abasia*, *Caligodes* and *Pseudanuretes* show every stage in the progressive reduction of the fourth leg. But apart from the first two genera the others have other distinguishing characters. *Pseudocaligus* and *Pseudolepeophtheirus* can, however, be retained on the grounds of convenience especially since these two are very rich in the number of species. If this is so I see no reason why *Metacaligus* Thomsen should not be given generic status.

This genus now includes eight species, *P. brevipedis* (Bassett-Smith), *P. apodus* Brian (1924). *P. fugu* Yamaguti (1936b), *P. laminatus* Rangnekar (1955b), *P. fistulariae* Pillai (1961), *P. tenuicauda* Shiino (1964) and *P. similis* Lewis (1968). The last two are synonyms of *P. fistulariae* Pillai.

Key to species of **Pseudocaligus**

| | | |
|---|---|---|
| 1. | Genital segment larger than cephalothorax | *.laminatus* Rangnekar |
| — | Genital segment smaller than cephalothorax | . 2 |
| 2. | Fourth leg represented by a single seta | *.parvus* (Bassett-Smith) |
| — | Fourth leg represented by a process carrying three setae | *fistulariae* Pillai |

## **Pseudocaligus fistulariae** Pillai
## (Fig. 126)

*Pseudocaligus fistulariae* Pillai, 1961, p. 112, fig. 14 ; 1967d, p. 1595, fig. 84.
*Pseudocaligus tenuicauda* Shiino, 1964, p. 249, figs. 3-4.
*Pseudocaligus similis* Lewis, 1968, p. 43, figs. 19-21.

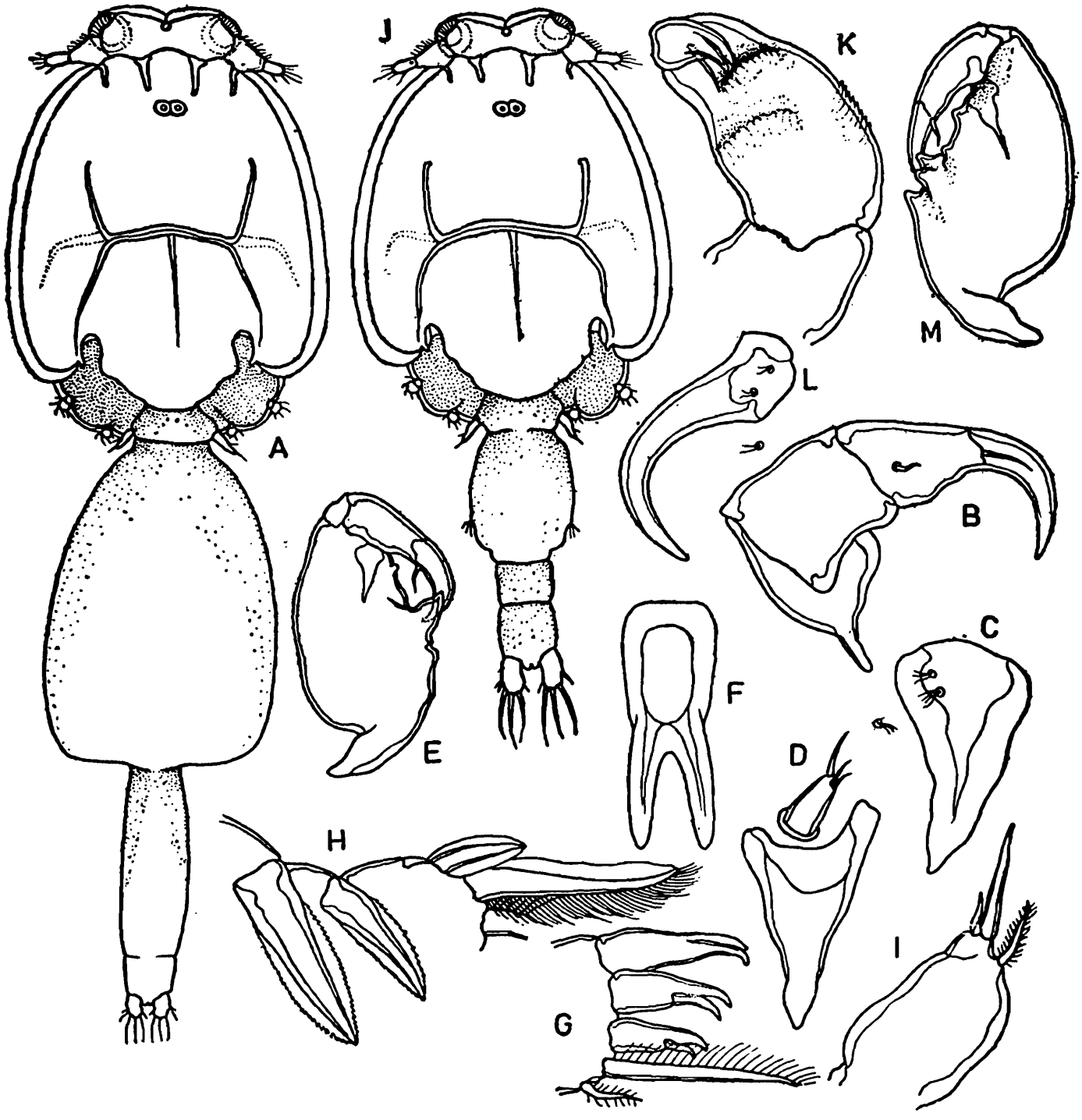


Fig. 126. *Pseudocaligus fistulariae* Pillai : A-I, Female. A, female, dorsal view; B, antenna; C, post-antennal process; D, post-oral process and maxillule; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, leg 4. J-M, Male. J, male, dorsal view ; K, antenna ; L, post-antennal process ; M, maxilliped.

*Female.*—Cephalothorax clearly longer than broad, frontal plates prominent and projecting, lunules large. Postero-median lobe about twice as broad as lateral lobes and prominently projecting, lateral lobes slightly curving inwards, making the posterior sinuses narrow. Genital segment large and widening backwards. Abdomen long and slender, two-jointed. Caudal rami longer than broad.

Antenna robust, basal segment with large apically rounded process, third segment strongly curved. Post-antennal process an irregular, triangular, apically narrowed process, post-oral short and traingular. Base of maxillule large and conical, setae comparatively small. Basal segment of maxilliped stout, its inner border with several processes of which one in the middle is high and acute, second segment comparatively stout and well curved. Sternal fork with parallel apically rounded limbs.

First leg short, distal segment with a small ventral seta, spine-like seta long, nearly straight and dorsally plumose. Claws short but stout, first apically bifid, others blunt or apically cut into lobes, with large accessory process. First two claws on exopod of second leg stout, with broad serrate wings, third very small, endopod segments hairy. Basal claw of exopod of third leg small and straight. Fourth leg an irregularly oblong stump with a dorsal plumose seta and two naked apical spines.

*Length.*—5.1 mm.

*Male.*—Genital segment small, roughly oval. Abdomen two-jointed, caudal rami large. Post-antennal process a stout strongly falcate claw. Second segment of antenna stout, with three adhesion pads, third short and bifid, with a long spine. Inner border of basal segment of maxilliped with four blunt processes, two of them high.

*Length.*—3.2 mm.

*Host.—Fistularia villosa, F. petimba.*

*Distribution.*—India (Kerala), Japan, Marshall Islands.

*Holotype* female and *allotype* male in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2138/2 & C2139/2.

*Remarks.*—Shiino was obviously unaware of my publication when he described *P. tenuicauda*. The fourth leg has an incomplete distal septum and when viewed in a particular angle would appear two-segmented and I described it as such. Subsepuent examination showed that it is exactly as in *P. tenuicauda* and *P. similis*. There is no doubt that only one species is involved and that the differences pointed out by Lewis are of an intraspecific nature.

### **Pseudocaligus laminatus** Rangnekar

*Pseudocaligus laminatus* Rangnekar, 1955b, p. 44, figs. 1-15 ; Yamaguti, 1963, p. 66, pl. 85, fig. 1 ; Pillai, 1967d, p. 1596, fig. 88.

*Female.*—Cephalothorax broadening backwards, frontal plates not projecting, postero-median lobe very slightly broader than lateral lobes, posterior sinuses fully open. Fourth thoracic segment small, genital segment very large, roughly rectangular and slightly constricted in the middle. Abdomen very short, one-segmented. Caudal rami very small.

Basal segment of antennule with long setae, distal segment short. Basal segment of antenna with short process, distal strongly curved. Post-antennal process a narrow straight claw, post-oral elongate triangular. Claws of maxilla large and winged. Distal segment of maxilliped with an accessory process subequal to the main claw in size. Limbs of sternal fork short and parallel.

Distal segment of first leg with fairly stout straight claws, second and third with small subsidiary process. First claw of exopod of second leg short and straight second and third small, basal segment of endopod with a patch of setules. Basal claw of exopod of third leg large, well curved. Fourth leg a small process carrying three setae, one of them short.

*Length.*—3.5 mm.

*Male.*—Cephalothorax broader, fourth segment longer, genital segment broadening backwards, with median lateral constriction. Abdomen one-segmented. Basal segment of antenna with one adhesion pad, second with two, third segment short, strongly curved, base swollen, with one spine. A pair of adhesion pads behind the oral cone.

*Length.*—1.5 mm.

*Host.—Gastrophysus lunaris.*

*Distribution.*—India (Bombay).

*Remarks.*—As I could not get a specimen for study this description is from Rangnekar. Rangnekar makes no mention of the spine-like seta usually present on the distal segment of the first leg. If the accessory claw of the maxilliped is really present it will be a unique character. This species needs redescribing.

**Pseudocaligus parvus** (Bassett-Smith)
(Fig. 127)

*Caligus parvus* Bassett-Smith, 1898a, p. 5, pl. 2, figs. 1-2 ; Wilson, 1905a, p. 557; Yamaguti, 1963, p. 57 ; Margolis *et al.*, 1975, p. 58.
*Pseudocaligus parvus* Rangnekar and Murti, 1964b, p. 43 ; Pillai, 1967d. p. 1592 fig. 78 ; 1969, p. 166, figs. 102-116.

*Male.*—Cephalothorax broadest behind, frontal plates low but projecting, lunules small, postero-median lobe very broad, slightly projecting. Fourth segment large, genital segment swollen, postero-laterally produced into traingular lobes carrying the vestigial legs. Abdomen short, one-segmented. Caudal rami with three large and three small setae.

Second segment of antenna with two projecting adhesion pads, third short and strongly curved. Post-antennal process long, curved and claw-like. Post-oral process reduced in size, a small triangular plate. Maxilla with short, stout claws, Basal segment of maxilliped produced into a very strong process, distal segment curved and stout, closing against the process on basal segment, producing some sort of a chela.

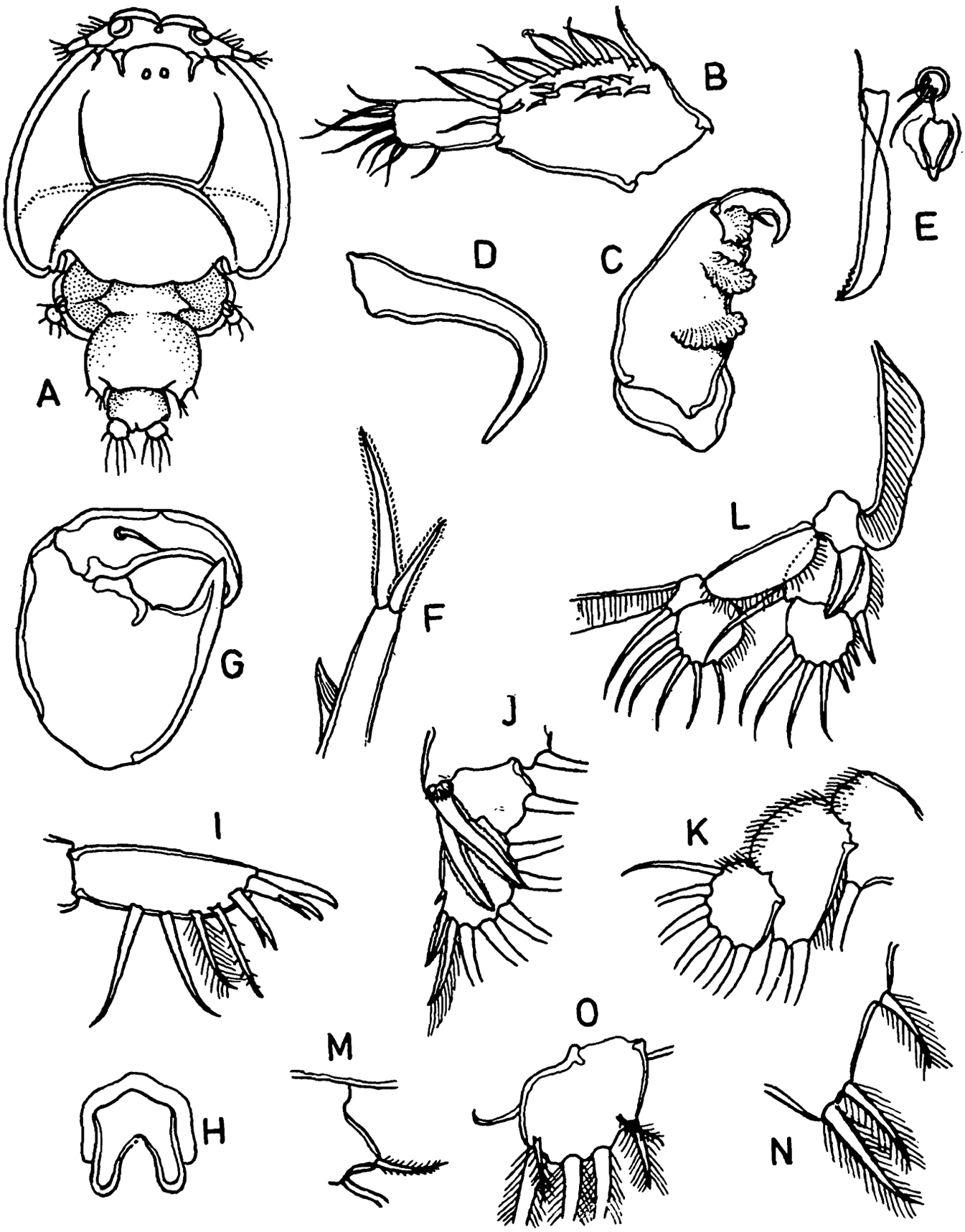


Fig. 127. *Pseudocaligus parvus* (Bassett-Smith) : A, male, dorsal view ; B, antennule; C, antenna; D, post-antennal process; E, post-oral process and maxillule ; F, maxilla ; G, maxilliped ; H, sternal fork ; I, leg I ; J, leg 2, exopod ; K, same, endopod ; L, leg 3 ; M, leg 4 ; N, leg 5 ; O, caudal ramus.

Distal segment of first leg with weak claws, second and third with accessory process, lower setae normal, spine-like seta similar to the lower setae but sparsely pectinate. First claw of exopod of second leg very long, third very small, endopod segments, pectinate. Basal claw of exopod of third leg large, winged. Fourth leg represented by a pectinate seta.

*Length.*—2.2 mm.

*Female.*—Cephalothorax narrowing backwards, postero-lateral lobes nearly as broad as median lobe. Genital segment swollen, three-fourths as broad as cephalothorax, postero-laterally produced into rounded lobes. Abdomen short, one-segmented. Antenna with slender distal segment. Post-antennal process a small curved claw with broad base. Spine-like seta on distal segment of first leg long. Maxilliped as in male but less robust.

*Length.*—3.4 mm.

*Host.—Tetrodon oblongus.*

*Distribution.*—India (Bombay).

*Type.* : in the British Museum (N.H)

*Remarks.*—The description of the male is based on a syntype in the British Museum. As no female was available for study the description of the female was extracted from Bassett-Smith which is not very satisfactory.

## Genus **Parapetalus** Stp. & Lutk.

*Parapetalus* Stp. & Lutk, 1961, p. 365 ; Bassett-Smith, 1899, p. 445 ; Wilson, 1908a, p. 606; Pillai, 1962c, p. 287 ; Yamaguti, 1963, p. 64 ; Cressey, 1967d, p. 4.

*Diagnosis.*—Cephalothorax like that of *Caligus.* Genital segment large, laterally drawn out into large, flattened wings making the segment subequal to cephalothorax (*hirsutus, longipennatus*) or the wings extending downwards and backwards into large lobes

(*orientalis*, *occidentlis*). Abodomen one or two-segmented, first segment produced into wings similar to those of genital segment (*hirsutus*, *orientalis*) or into large lobes (*occidentalis*). Appendages as in *Caligus*.

Male without lobes or wings on genital and abdominal segments. Appendages not showing the same extent of dimorphism as in *Caligus*.

Parasites of teleosts.

Type species : *P. orientalis* Stp. & Lutk.

*Discussion*.—Pillai (1962c) assigned five species to this genus. Of these *P. gunteri* Pearse (1952) is a synonym of *P. occidentalis*, *P. orientalis* and *P. occidentalis* have true wings but *P. hirsutus* and *P. longipennatus* have only flattened genital segment and abdomen similar to those of *Caligus parapetalepsis* Hameed and Pillai and *C. grandiabdominalis* Yamaguti. An identical enlargement of the genital segment and abdomen is seen in *Abasia* Wilson and *Alicaligus* Shiino. *P. hirsutus* differs from the rest so widely that there is sufficient justification in returning it to *Caligus* where it was originally placed.

Key to species of **Parapetalus**

| | | |
|---|---|---|
| 1. | Genital segment as broad as cephalothorax | .2 |
| — | Genital segment broader than cephalothorax | .3 |
| 2. | Abdomen as broad as genital segment, fourth leg modified, with four bunches of hairs | .*hirsutus* (Bassett-Smith) |
| — | Abdomen broader than genital segment, fourth leg normal, without bunches of hairs | .*logipeannatus* Rangnekar |
| 3. | Wings of genital segment subsimilar to those of abdomen, curling downwards | .*occidentalis* Wilson |
| — | Wings of genital segment larger than those of abdomen, horizontal | .*orientalis* Stp. & Lutk |

## **Parapetalus hirsutus** (Bassett-Smith)
(Fig. 128)

*Caligus hirsutus* Bassett-Smith, 1898a, p. 5, pl. 3, figs. 1-2 ; Shen, 1957b, p. 373, pl. 8 ; Yamaguti, 1963, p. 54, p.l 63, fig. 5, pl. 83, fig. 4.
*Parapetalus hirsutus* Wilson, 1912a, p. 239, pl. 33, figs. 28-35 ; Kirtisinghe, 1950, p. 77, figs. 1-4 ; 1964, p. 69, figs. 72-73 ; Pillai, 1962c, p. 288, fig. 1.

*Female.*—Cephalothorax longer than broad, lunules inconspicuous, postero-lateral lobes slightly overreaching median lobe. Fourth segment broad. Genital segment laterally expanded, nearly circular, as broad as cephalothorax, postero-laterally forming rounded lobes overlapping abdomen. Abdomen one-jointed, as broad as but longer than genital segment, postero-laterally forming small lobes. Caudal rami large, longer than broad.

Basal segment of antenna produced into a sharp process. Post-antennal process small, irregular, post-oral of the usual type, triangular. Apical claws of maxilla short. Maxilliped slender, distal segment long and strongly curved. Sternal fork with very broad base, limbs short, flattened, apically rounded and parallel.

Dorsal seta on protopod of first leg long, vestigial endopod oval and hairy, distal segment of exopod with stout lower setae, spine-like seta small and naked, claws spiny, second and third with large subsidiary process. First claw of exopod of second leg nearly straight, large, second smaller, third very small, endopod segments with broad patches of setules. Apron of third leg reduced in size, curiously deformed, velum very large and profusely hairy, basal claw of exopod small and externally flanged, its base produced outwards. Fourth leg four-segmented, with five shovel-shaped claws, first with a basal row of spinules, others with a bunch of hairs.

*Length.*—7.9 mm.

*Male.*—Membranous flange of cephalothorax posteriorly angular. Genital segment not enlarged, abdomen long and slender, three-segmented. Caudal rami long, with one of the setae very long. Post-antennal process a broad based stout claw. Second segment of antenna with a large adhesion pad, third long and strongly bent. Maxillule very small. Basal segment of maxilliped

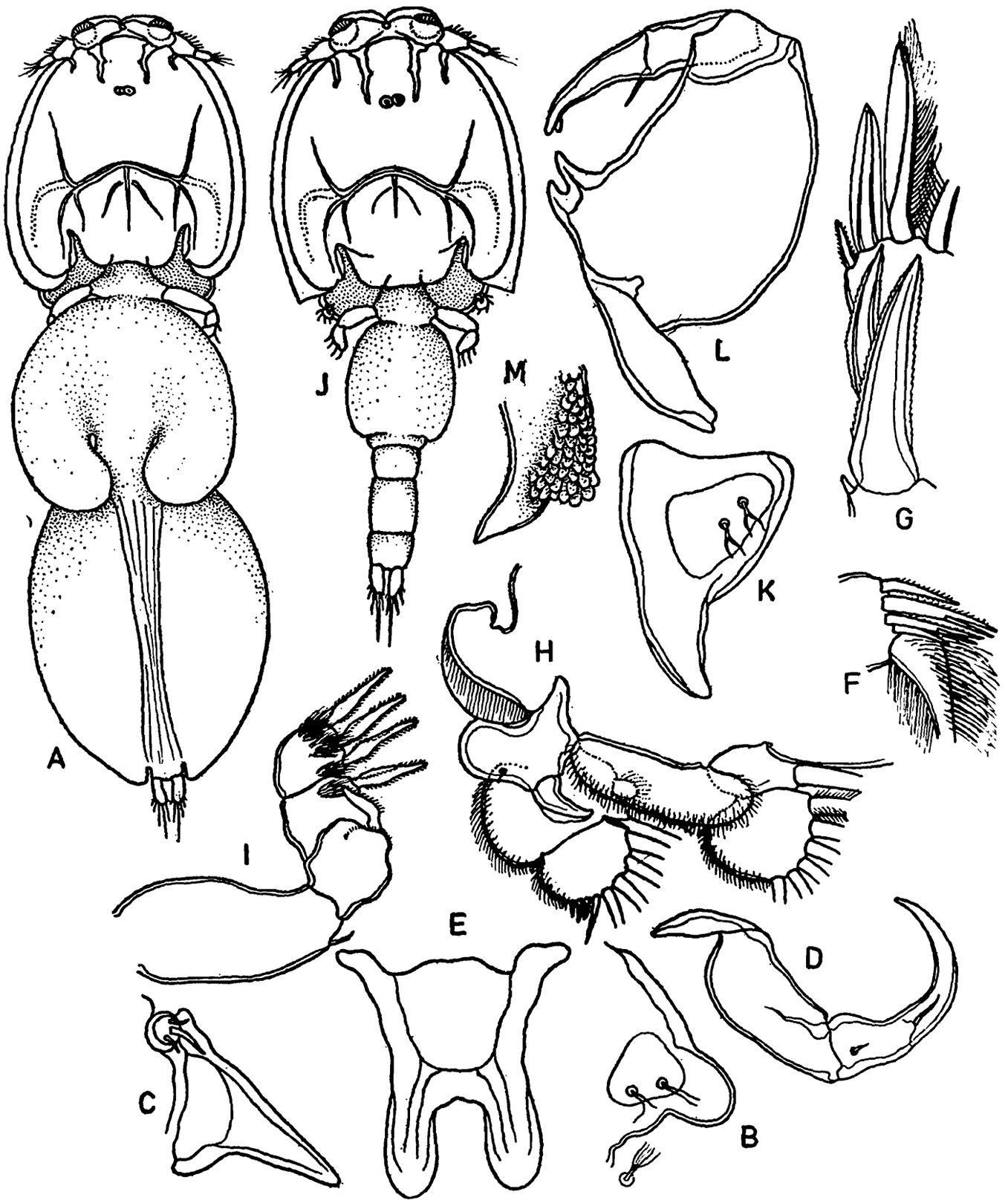


Fig. 128. *Parapetalus hirsutus* (*Bassett-Smith*) : A-1, Female. A, female, dorsal view ; B, post-antennal process ; C, post-oral process and maxillule ; D, maxilliped ; E, sternal fork ; F, leg 1 ; G, leg 2, exopod ; H, leg 3 ; I, leg 4. J-M, Male. J, male, dorsal view ; K, post-antennal process ; L, maxilliped ; M, same, tip of distal segment.

massive, with a strong bifid process, distal segment with subapical cluster of blunt teeth, making the tip appear bifid. Fourth leg very small, without bunches of hairs.

*Length.*—4.4 mm.

*Host.—Eleutheronema tetradactylum, Polynemus plebeius.*

*Distribution.*—India (Bombay, Kerala), China, Batavia.

*Remarks.*—The most curious character of this species is the twisted fourth leg. An identical type of leg is present in *Caligus kanagurta* Pillai and identical bunches of hairs in *C. distortus* Pillai and Natarajan.

**Parapetalus longipennatus** Rangnekar
(Fig. 129)

*Parapetalus longipennatus* Rangnekar, 1956, p. 46, figs. 1-p ; Pillai, 1962c, p. 290 ; Yamaguti, 1963, p. 65, pl. 84, fig. 4 ; Hameed and Pillai, 1972b, p. 329, figs 1-17.

*Female.*—Cephalothorax nearly circular, with projecting frontal plates, postero-median lobe only slightly broader than lateral lobes but clearly reaching beyond them. Fourth segment slightly broader than long, partially fused with genital segment. Genital segment enlarged and flattened, slightly broader than cephalothorax, anteriorly with distinct neck, postero-laterally expanded into large rounded lobes overlapped by the abodomen. Abdomen one-segmented, flattened and nearly circular, much larger than cephalothorax and genital segment, with deep posterior sinus housing the caudal rami.

Basal segment of antenna partially fused with cephalothorax, process flattened and rounded, third segment long, slender and strongly curved. Post-antennal process small, claw flanged, accessory process on base large. Post-oral process with broad base, apically flat and rounded, accessory lobe large. One of the setae of maxillule long. Maxilliped stout, basal segment with proximal inner bulge, distal segment stout, distal part with a patch of pustules. Sternal fork with stout base, rami parallel and flanged.

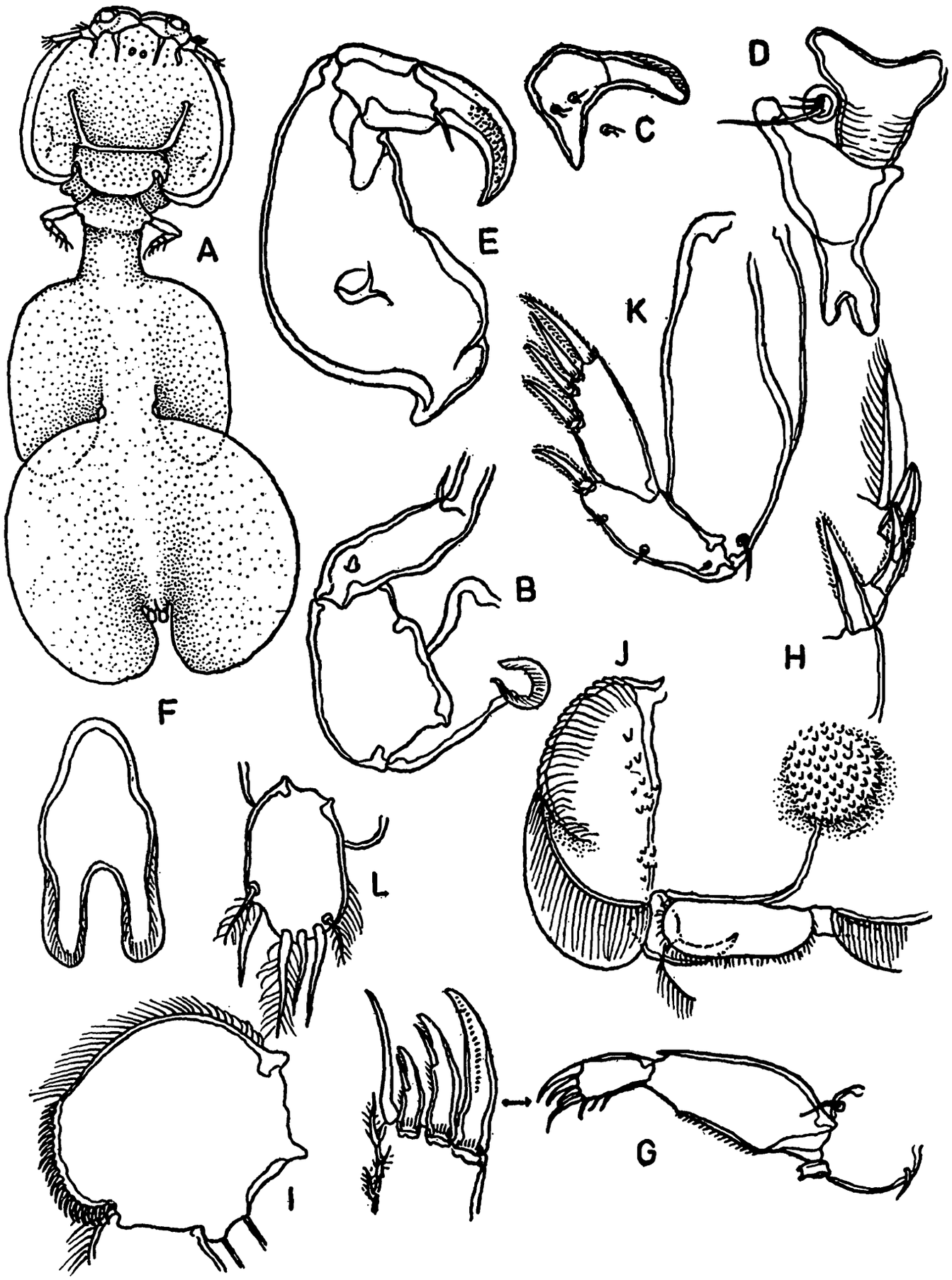


Fig. 129. *Parapetalus longipennatus* Rangnekar : A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, same, endopod ; J, leg 3 ; K, leg 4 ; L, caudal ramus.

Basipod of first leg spiny, vestigial endopod with two spines, distal segment of exopod with three small lower setae, claws successively decreasing in length, ventrally spiny, second and third with long slender accessory process, spine-like seta as long as first claw, naked. Basal segment of endopod of second leg bulging, partly hairy and partly spiny, other segments hairy, claws on exopod steadily decreasing in size. Rami of third leg placed wide a part, claw of exopod strongly curved, apron with outer adhesion pad, a long patch of teeth and a circular patch of teeth. Fourth leg much flattened, three-segmented, basal segment large, claws with pectinate wings.

*Length.*—3.0 mm.

*Host.*—*Caranx ignobilis, C. stellatus, C. nigrescens.*

*Distribution.*—India (Bombay, Kerala).

*Remarks.*—This species is a true *Parapetalus* but so closely resembles *Caligus parapetalopsis* that the difference between *Parapetalus* and *Caligus* breaks down completely. There is hardly any character which clearly distinguishes these two genera.

**Parapetalus occidentalis** Wilson
(Fig. 130)

*Parapetalus accidentalis* Wilson, 1908a, p. 606, pl. 53 ; Pillai, 1962c, p. 292. fig. 3 ; Yamaguti, 1963, p. 65, pl. 84, fig. 2.

*Parapetalus gunteri* Pearse, 1952, p. 24, figs. 87-93 ; Pillai, 1962c, p. 295, fig. 4 ; Yamaguti, 1963, p. 65, pl. 84, fig. 3 ; Kabata, 1966c, p. 567.

*Female.*—Cephalothorax broader than long, frontal plates low, lunules small, postero-median lobe slightly broader than lateral lobes, not projecting. Fourth segment short, fused with genital segment, latter short but laterally drawn out into large foliaceous lobes extending far outwards and backwards up to the tip of the abdomen. Abdomen twice as long as genital segment, like the latter prolonged into large wings overlapping those of the genital segment. In live specimens the wings curve downwards overlapping in the middle. Caudal rami longer than broad.

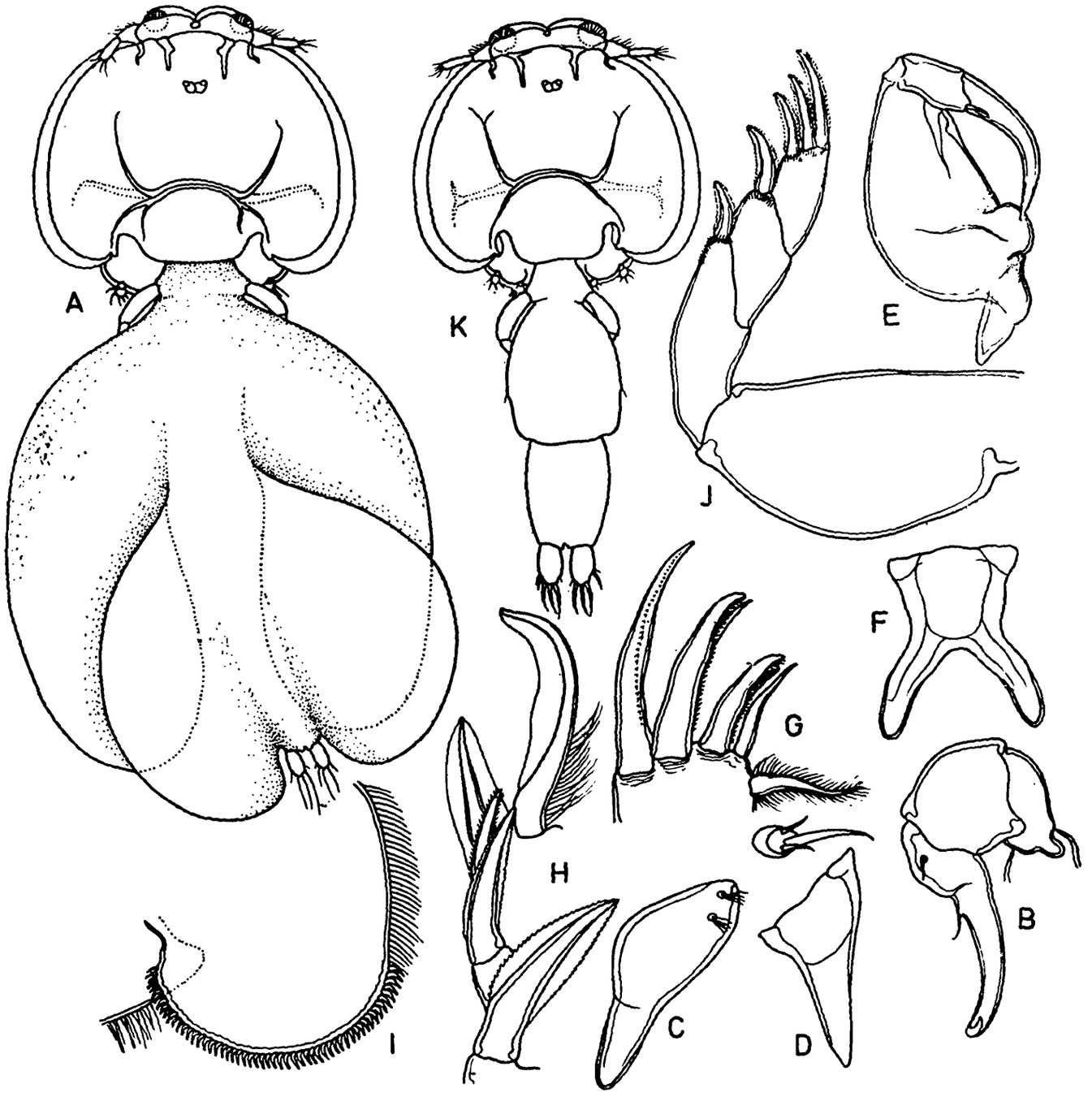


Fig. 130. *Parapetalus occidentalis* Wilson : A-J, Female. A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, same, endopod ; J, leg 4. K, Male, dorsal view.

Distal segment of antennule long. Basal segment of antenna with rounded process, third segment slender. Post-antennal process with broad base and short claw, post-oral elongate triangular. Basal segment of maxilliped with large basal inner boss, distal strongly curved. Limbs of sternal fork irregular, strongly diverging.

Distal segment of first leg with the usual armature. First claw of exopod of second leg with broad serrate wings, second with narrow wings, third spiny, basal endopod segment wiih a row of, short spines, others hairy. Basal claw of exopod of third leg slender and strongly curved. Fourth leg four-segmented, basal segment broad.

*Length.*—7.3 mm.

*Male.*—Genital segment and abdomen small, without wings, abdomen one-segmented. Caudal rami large. Antenna and post-antennal process not modified.

*Length.*—3.1 mm.

*Host.*—*Rachycentron canadus*, *Johnius* sp.

*Distribution.*—North Carolina, Louisiana, Queensland, Sri Lanka, India (Kerala).

## **Parapetalus orientalis** Spt. & Lutk.
(Fig. 131)

*Parapetalus orientalis* Stp. & Lutk., 1861, p. 365, fig. 10 ; Pillai, 1962c, p. 290 fig. 2 ; Yamaguti, 1963, p. 65, pl. 83, fig. 3.

*Female.*—Hind border of cephalothorax nearly transverse, frontal plates rather low, not projecting. Postero-median lobe narrower than lateral lobes, not projecting. Genital segment laterally expanded into large wings extending backwards as two rounded lobes nearly reaching the tip of the abdomen. Abdomen apparently two-jointed, anterior part of first segment prolonged into, elongate oblong petaloid lobes overlapping the wings of the genital segment and reaching far beyond the abdomen, free part of segment with convex sides, second segment very short.

Antennule and antenna as in *P. occidentalis.* Post-antennal proess small, other cephalic appendages similar to those of *P. occidentalis.* Limbs of sternal fork slender and diverging.

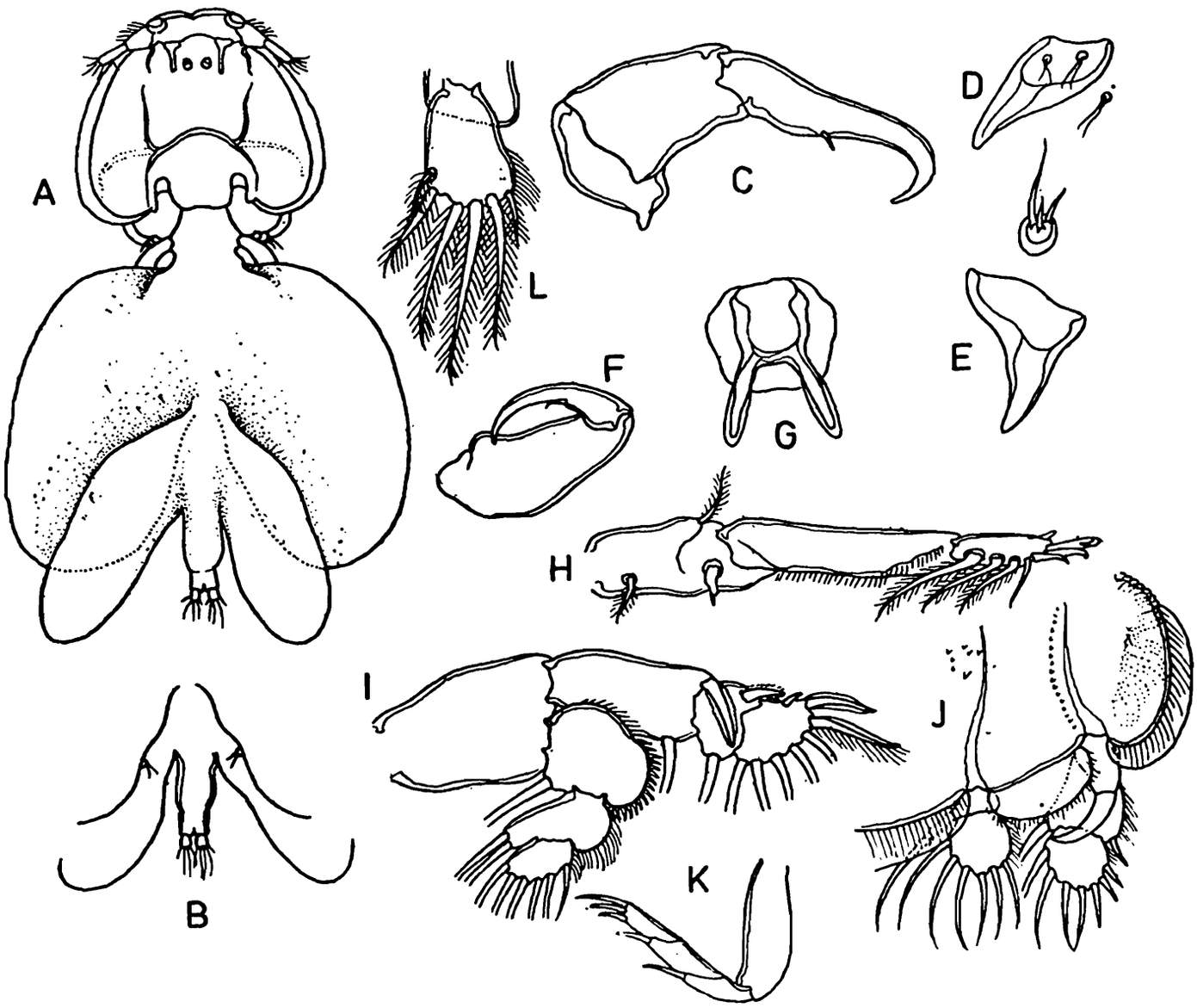


Fig. 131. *Parapetalus orientalis* Stp. & Lutk. : A, female, dorsal view ; B, posterior end of body, ventral view ; C, antenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, maxilliped ; G, sternal fork ; H, leg 1 ; I, leg 2 ; J, leg 3 ; K, leg 4.

First leg with the usual armature. Second leg as in *P. occidentalis*, basal segment of endopod bulging, proximal part of its outer border hairy, distal part with a crest of sharp spines. Basal claw of expode of third leg slender and strongly curved. Fourth leg four-segmentd, claws short, winged and successively becoming longer.

*Length.*—2.7 mm.

*Host.—Alectis indicus.*

*Distribution.*—East Indies, Indian Ocean, India (Kerala).

Female in National Zoological Collection at Z.S.I., Calcutta, Reg. No. C2140/2.

## Genus **Pseudopetalus** Pillai

*Pseudopetalus* Pillai, 1962c, p. 296 ; Cressey, 1967d, p. 4.

*Diagnosis.*—Cephalothorax like that of *Caligus* and *Parapetalus* but comparatively very small. Frontal plates projecting, lunules small. Postero-median lobe broader than lateral lobes and projecting. Genital segment elongated and swollen, not winged, much longer than cephalothorax. Abdomen similar to genital segment, enlarged but not winged. Caudal rami small. Appendages as in *Parapetalus*. Endopod of second leg with two to three rows of teeth. Fourth leg short, three-segmented, claws successively decreasing in length, except in *P. dussumieri*.

Male unknown.

Parasites of teleosts (clupeids).

Type species : *P. caudatus* (Gnanamuthu).

*Discussion.*—This genus includes only three species, all so far known only from the Indian waters. They are fairly abaundant and are found only on clupeid fishes.

*Caligus proboscidiatus* Heegaard (1962) may be the male of *Pseudopetalus*.

### Key to species of **Pseudopetalus**

1. Distal segment of first leg with long well developed plumose setae — *dussumieri* (Rangnekar)
— Distal segment of first leg with short spines instead of setae — .2

2. Abdomen rounded — .*caudatus* (Gnanamuthu)
— Abdomen elliptic — *formicoides* (Redkar *et al.*)

## **Pseudopetalus dussumieri** (Rangnekar)
(Fig. 132)

*Caligus dussumieri* Rangnekar, 1957b, p. 18, fig. 2 ; Yamaguti, 1963, p. 52 ; Margolis *et al.*, 1975, p. 31.

*Pseudopetalus dussumieri* Pillai, 1967d, p. 1599, fig. 92; 1968b, p. 13, fig. 3.

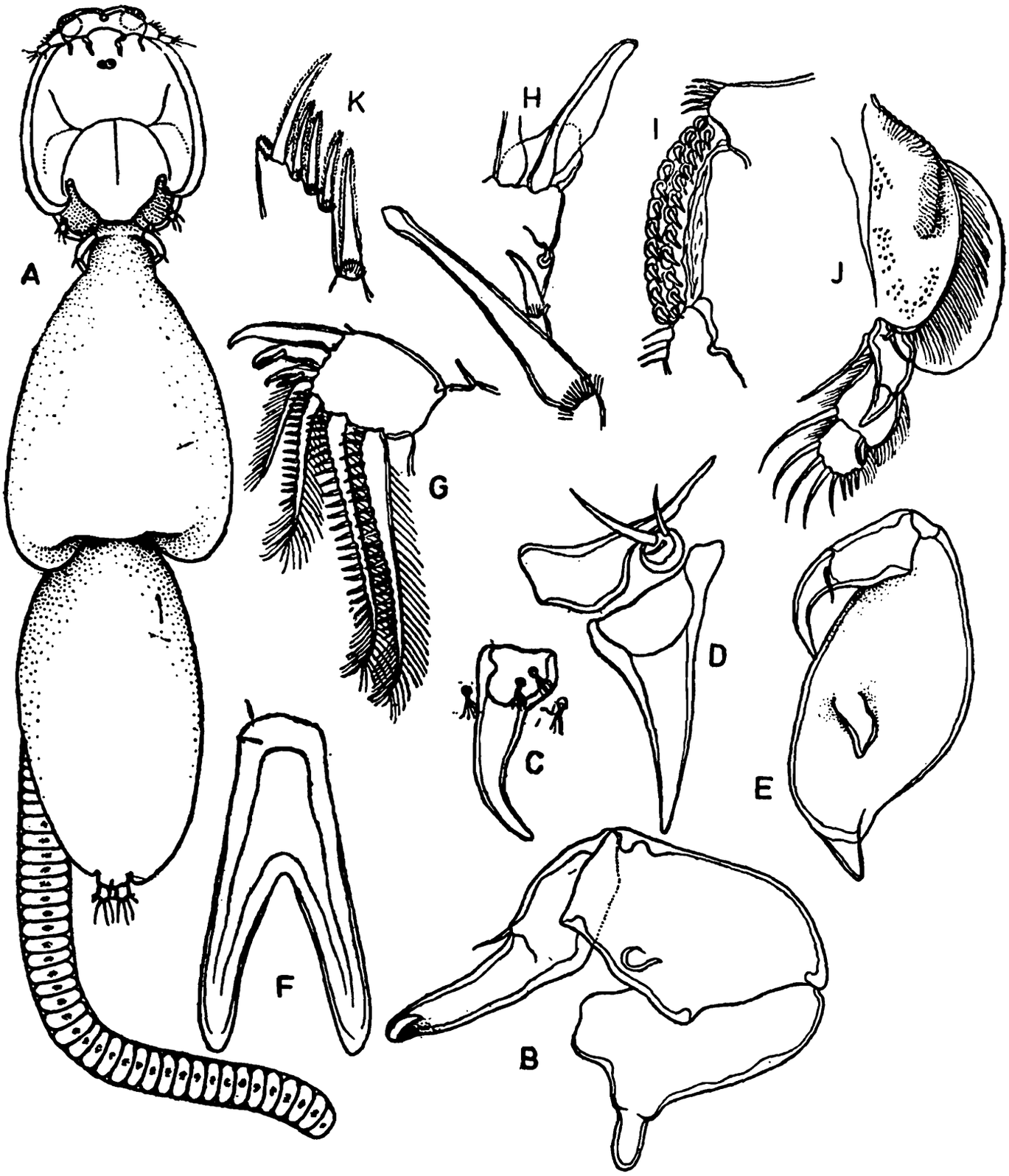


Fig. 132. *Pseudopetalus dussumieri* (Rangnekar) ; A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, same, endopod ; J, leg 3 ; K, leg 4.

*Female.*—Cephalothorax longer than broad, with deep projecting frontal plates, lunules prominent, postero-median lobe more than twice as broad as lateral lobes, distally narrowed. Posterior sinuses partially closed. Fourth segment broader than long, genital segment large, longer and broader than cephalothorax, with anterior neck, postero-laterally with rounded lobes. Abdomen one-segmented, elongate oblong, slightly longer than genital segment. Caudal rami small, with longer highly plumose setae.

Basal segment of antenna with short apically rounded process, third segment distally recurved. Post-antennal process stout and slightly curved, post-oral an elongated strong claw. Apical claws of maxilla short. Basal segment of maxilliped stout, with conical process, distal segment short and well curved. Limbs of sternal fork long, apically rounded and diverging.

First leg short but broad, distal segment with very long setae externally armed with well spaced spines, claws short and smooth, second and third with accessory process, spine-like seta longer than the claws, abruptly bent near base. First claw of exopod of second leg very long, smooth and apically expanded, second claw short and smooth, third minute, first seta very small, with broad ventral wing converting it into a limina, basal segment of endopod with a row of about five spines, second segment with three rows of incurved teeth. Basal claw of exopod of third leg slightly curved, rami placed wide apart. Fourth leg small, basal segment longer than rest of limb, first and fifth claws subequal, others shorter.

*Length.*—5.2 mm.

*Host.—Dussumieria hasselti, D. acuta.*

*Distribution.*—India (Bombay, Kerala).

**Pseudopetalus caudatus** (Gnanamuthu)
(Fig. 133 B-C, 134 A-H)

*Parapetalus caudatus* Gnanamuthu, 1950a, p. 125, figs. 1-5 ; Yamaguti, 1963, p. 65, pl. 83, fig. 1.

*Pseudopetalus caudatus* Pillai, 1962c, p. 299. fig. 6.

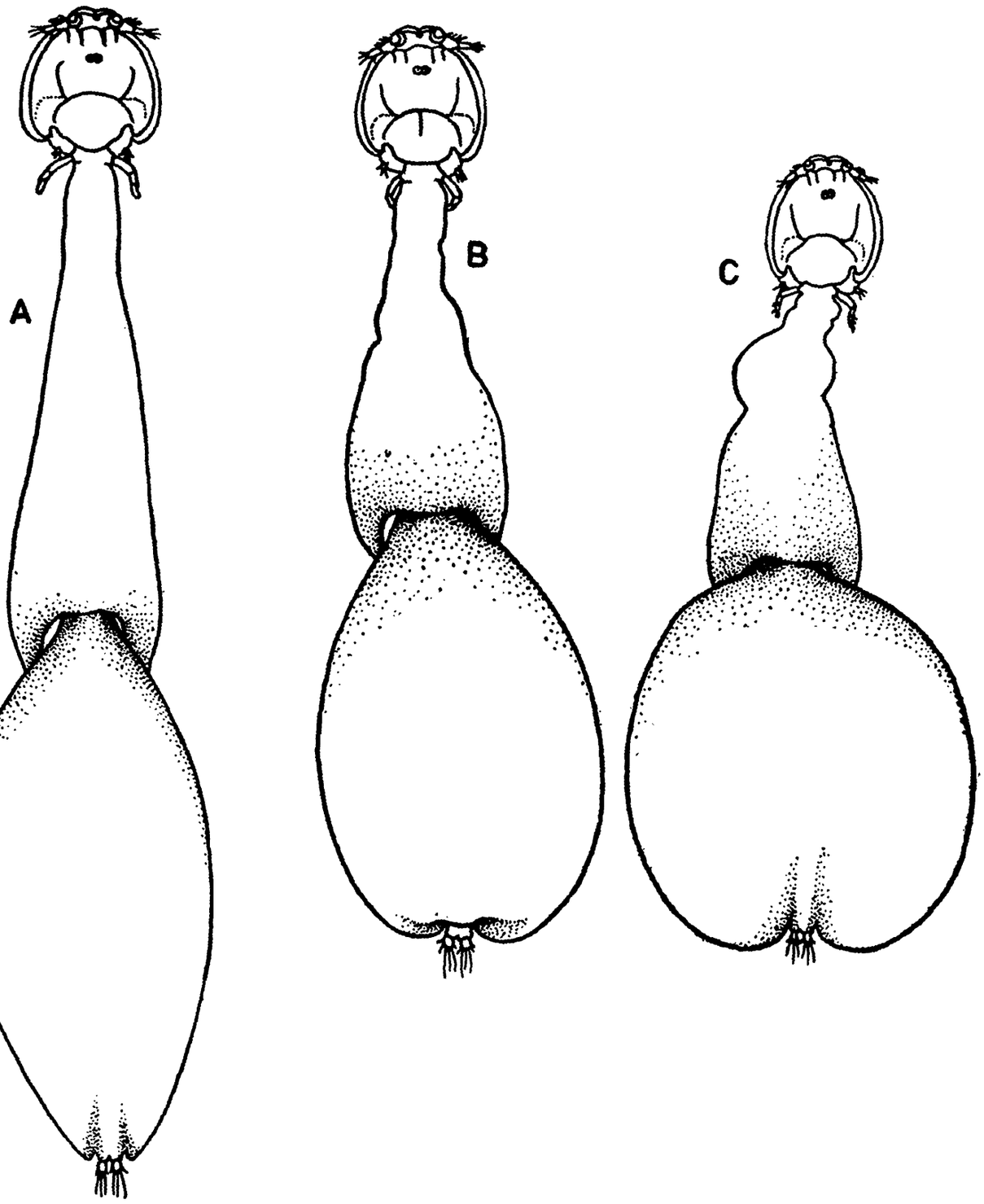


Fig. 133. A. *Pseudopetalus formicoides* (Redkar *et al*), female, dorsal view ; B-C. *Pseudopetalus caudatas* (Gnanamuthu), females, dorsal view.

*Female.*—Cephalothorax very small, slightly longer than broad, frontal plates projecting, lunules prominent. Postero-median lobe

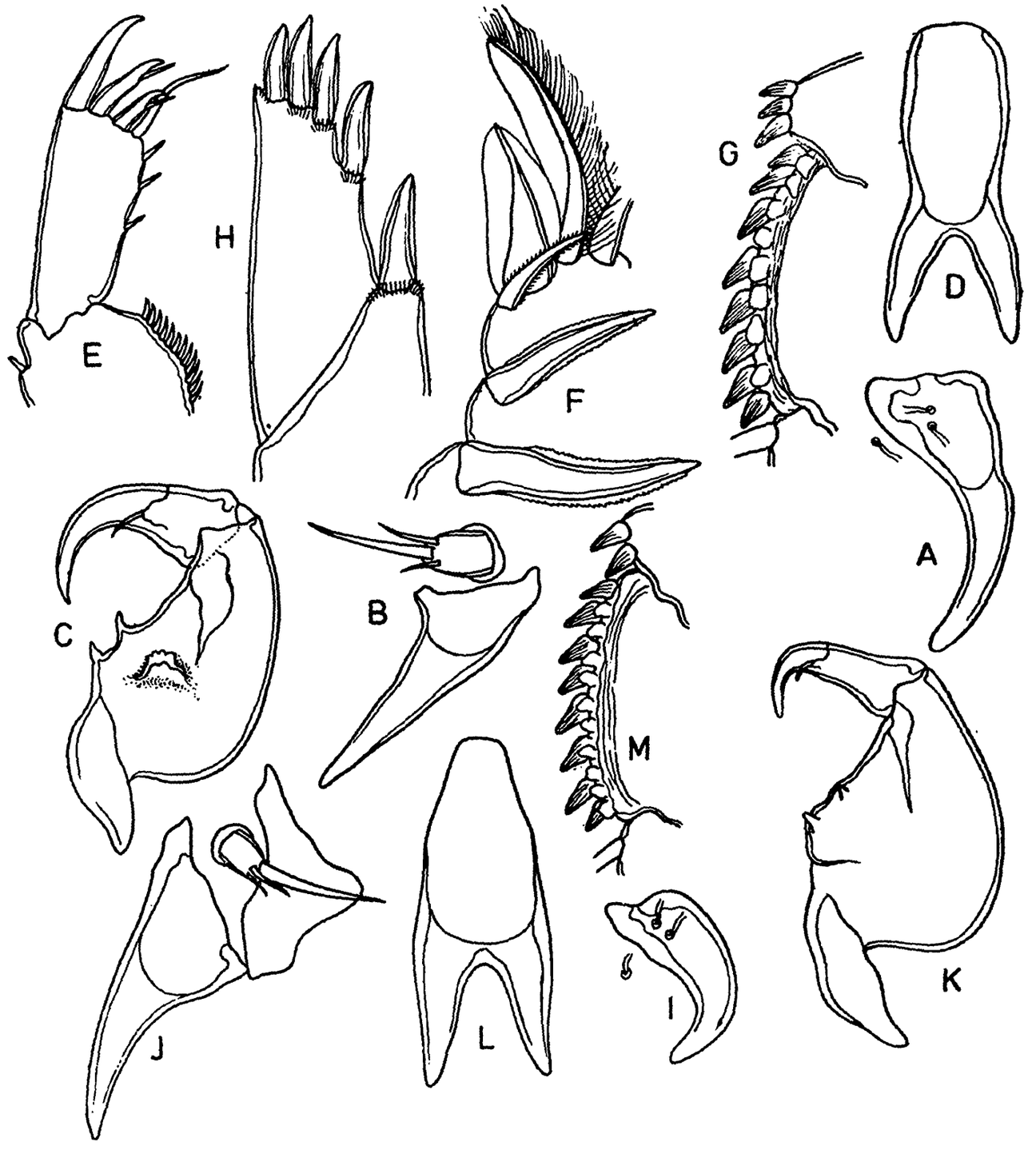


Fig. 134. A-H. *Pseudopetalus caudatus* (contd.) : A, post-antennal process ; B, post-oral process and maxillule ; C, maxilliped ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 4. I-M. *Pseudopetalus formicoides* (contd.) : I, post-antennal process ; J, post-oral process and maxillule ; K, maxilliped ; L, sternal fork ; M, leg 2, endopod.

about four times as broad as lateral lobes and projecting. Genital segment much elongated, steadily widening backwards, postero-laterally produced into conical lobes. Abdomen highly flattened, longer than genital segment, one and a half times as long as broad, tip free of expansion. Caudal rami small.

Basal segment of antenna with long sharp process. Post-antennal process a stout slightly curved claw, post-oral strong, narrowing and apically actue. Claws of maxilla short. Maxilliped stout, basal segment with two sharp narrow processes and a broad projecting lobe on one side, second segment strongly curved. Sternal fork with long base and short distally narrowed diverging rami.

Basipod of first leg spiny, first segment of exopod with a row of teeth, distal segment with three short spines instead of setae, spine-like seta long and naked, claws smooth, second and third with accessory process. First two claws on exopod of second leg with narrow serrate wing, third spiny, first seta with broad wings first segment of endopod with a row of three strong teeth, second with about eight to ten teeth. Basal claw of exopod of third leg slender. Fourth leg short, three-segmented, basal segment longer than rest of limb, claws short, successively decreasing in length.

*Length.*—8.5 mm.

*Host.—Dussumieria acuta, D. hasselti, Ablennes hians.*

*Distribution.*—India (Madras, Kerala).

**Pseudopetalus formicoides** (Redkar, Rangnekar and Murti)
(Fig. 133A, 134 I-M)

*Caligus formicoides* Redkar *et al.*, 1949, p. 36.

*Parapetalus formicoides* Rangnekar and Murti, 1950b, p. 44 ; Yamaguti, 1963, p. 65.

*Sinocaligus denticulatus* Shen, 1957b, p. 375, pl. 10.

*Parapetalus denticulatus* ; Shen, 1958, p. 142 ; Yamaguti, 1963, p. 65, pl. 83 fig. 2.

*Pseudopetalus formicoides* Pillai, 1962c, p. 297, fig. 5.

*Female.*—Cephalothorax similar to that of *P. caudatus* but shorter, equal in length and width, postero-median lobe distally rounded. Genital segment as in *P. caudatus* but more slender. Abdomen long elliptic, longer and narrower than in *P. caudatus.*

Appendages as in *P. caudatus.* Post-antennal process shorter but stouter, post-oral stouter and slightly more curved. Basal segment of maxilliped with two small spines, distal segment very slender and distally bent at right angles. Sternal fork with long base, rami short, not diverging.

Legs differing from those of *P. caudatus* only in the armature of the endopod of the second leg. Third claw of exopod comparatively shorter, first seta with broader wings. Basal segment of fourth leg broader than that of *P. caudatus* but other segments narrower.

*Length.*—10.2 mm.

*Host.—Dussumieria acuta, D. hasselti, Sardinella fimbriata.*

*Distribution:*—India (Bombay, Kerala), China.

## Genus **Sciaenophilus** van Beneden

*Sciaenophilus*, Wilson, 1905a, p. 533 ; Yamaguti, 1963, p. 66 ; Cressey, 1967d, p. 4.

*Diagnosis.*—Cephalothorax as in *Caligus.* Frontal plates with lunules. Fourth thoracic segment small, often fused with genital segment. Genital segment longer than cephalothorax, often swollen, widening backwards. Abdomen long and slender, longer than rest of the body. Caudal rami large. Appendages as in *Caligus.* Sternal fork absent.

Male showing the same type of sexual dimorphism as in *Caligus.*

Parasites of teleosts (mainly sciaenids).

Type species : *S. tenuis* van Beneden.

*Discussion.*—This genus contains five species divisible into two groups. *S. benedeni* (Bassett-Smith, 1898a), *S. benetti* (Causey, 1953) and *S. macrurus* (Heller, 1868) have the long abdomen characteristic of the type species. But in *S. pharaonis* (Nordmann, 1832) and *S. nibeae* (Shen, 1957b) the abdomen is comparatively very short but much swollen. Nevertheless all show identity in the structure of the first and fourth legs and the absence of the sternal fork.

Key to species of **Sciaenophilus**

1. Abdomen much longer than rest of body ..... *.tenuis* (van Beneden)
— Abdomen only slightly longer than rest of body ..... .2

2. Fourth leg four-jointed ..... *benedeni* (Bassett-Smith)
— Fourth leg three-jointed ..... *.pharaonis* (Nordmann)

## **Sciaenophilus benedeni** (Bassett-Smith)

*Caligus* (*Sciaenophilus*) *benedeni* Bassett-Smith, 1898a, p. 9, pl. 3, fig. 3.

*Caligus benedeni* Thomson and Scott, 1903, p. 294 ; Capart, 1941, p. 172 ; Kirtisinghe, 1964, p. 64.

*Sciaenophilus benedeni* Bere, 1936, p. 587 ; Pillai, 1967d, p. 1600, fig. 95.

*Host.*—*Johnius diacanthus, J. angolenis, J. holoepidotus.*

*Distribution.*—Bombay, Gulf of Mexico, West Afria, Sri Lanka.

*Remarks.*—The only detailed description of this species so far available is that of Bassett-Smith which is not at all satisfactory. As I have no specimen the following summary of characters is from Bassett-Smith.

Cephalothorax one-fifth of the total length, narrower than genital segment. Antenna small, sharply bent. Maxilla (first maxilliped) very slender. Maxilliped (second maxilliped) with very strong simple distal segment. First leg with three long claws and three moderately long plumose setae. Fourth leg with four long slightly curved

terninal claws and a fifth half way down the inferior border. Genital segment longer than broad, much larger than cephalothorax. Abdomen long, thick, single-jointed, constricted at base. Caudal rami longer than broad.

*Length.*—6.0 mm.

This description seems to apply to *S. pharaonis* which is common along the west coast of India. *S. benedeni* may be the same as *S. pharaonis* (Nordmann).

## **Sciaenophilus pharaonis** (Nordmann)
(Fig. 135)

*Caligus pharaonis* Nordmann, 1832, p. 29.

*Lepeophtheirus pharaonis* Wilson, 1905aa, p. 201 ; Yamaguti, 1963, p. 76.

*Sciaenophilus inopinus* Humes, 1957, p. 201 ; Rangnekar, 1959, p. 43 ; Yamaguti 1963, p. 66, pl. 82, fig. 3.

*Sciaenophilus pharaonis* ; Humes, 1965, p. 1009 ; Pillai and Natarajan, 1977, p. 34, figs. 81-91.

*Female.*—Cephalothorax comparatively small, equal in length and width, postero-median lobe broader than lateral lobes and projecting far beyond the latter, lateral lobes curving inwards. Lunules small and indistinct. Fourth segment fused with genital segment, latter with short anterior neck, rest of the segment nearly circular and highly swollen, postero-laterally rounded and slightly produced. Abdomen longer than rest of body, two-segmented, first segment gradually narrowing backwards, second very short, much narrower than first. Caudal rami oblong, with four long and two short plumose setae. Egg tubes shorter than abdomen, with fairly large eggs.

Antenna stout and strong, its basal segment small, without process, third segment very strong, with swollen base carrying a long seta. Post-antennal process small, with swollen base. Post oral long and narrow, apically acute. Claws of maxilla stout, with

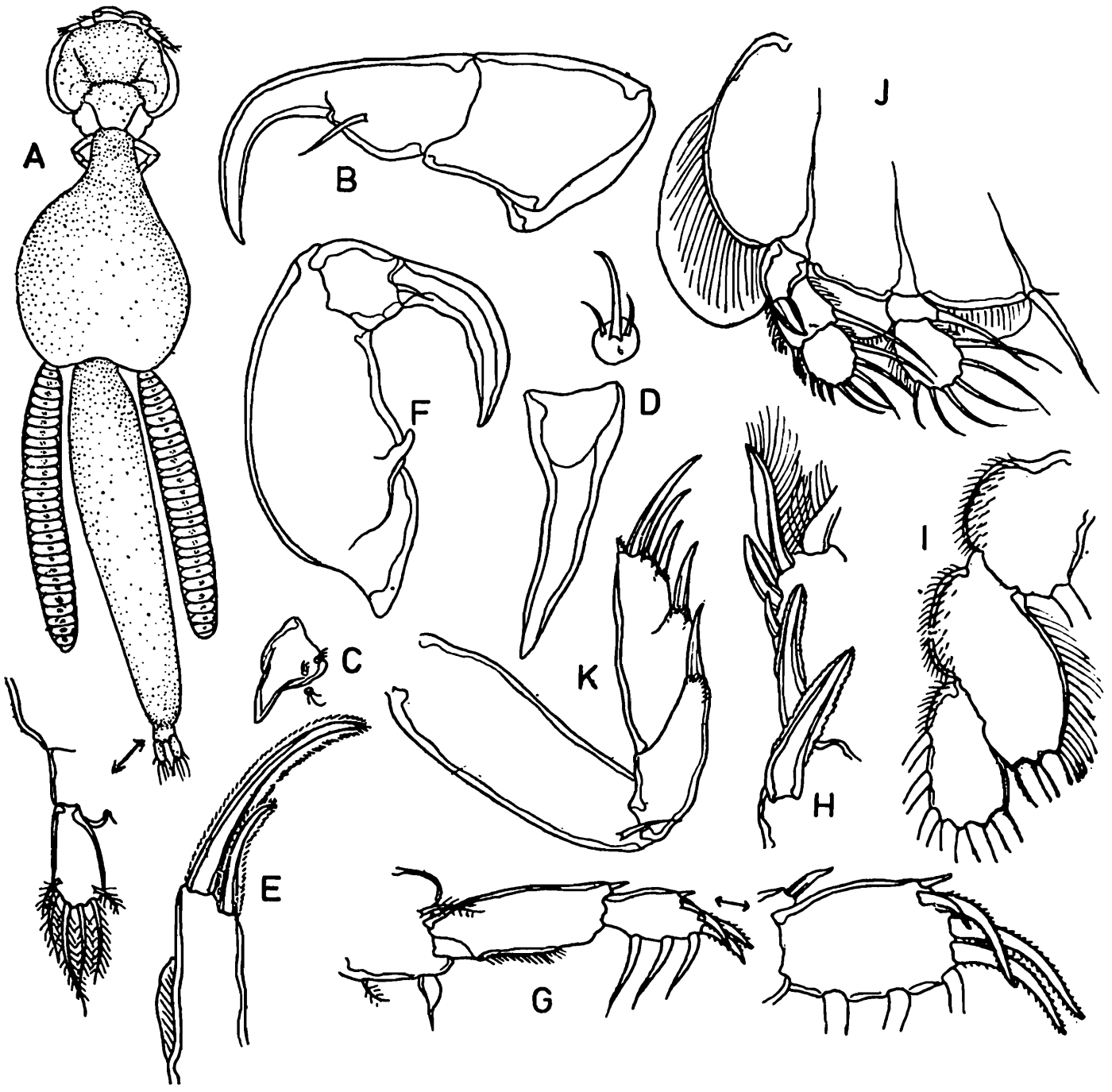


Fig. 135. *Sciaenophilus pharaonis* (Nordmann) : A, female, dorsal view ; B, antenna; C, post-antennal process; D, post-oral process and maxillule; E, maxilla; F, maxilliped; G, leg 1; H, leg 2, exopod; I, same, endopod ; J, leg 3 ; K, leg 4.

broad pectinate wings. Maxilliped robust, basal segment with small proximal inner process, claw large, strongly curved.

Basipod of first leg with one upper and one lower setae, vestigial endopod flattened, with apical spinule, distal segment with five subsimilar claws, first small and sharp, second curved and smooth,

third, fourth and fifth sparsely spiny, ventral setae moderately large. First two claws on exopod of second leg subsimilar and flanged, third small, segments of endopod with stiff hairs. Basal claw of exopod of third leg slightly curved, with narrow wings. Fourth leg broad, three-segmented, wih five feebly winged claws. basal segment as long as rest of limb, third segment with an incomplete partition.

*Length.*—6.2 mm.

*Host.—Chrysophrys bifasciatus, C. aurata, Lates niloticus, Labeo forskali, Sciaena semiluctuosa.*

*Distribution.*—Red Sea, Egypt, India (Bombay, Kerala).

*Remarks.*—The highly swollen genital segment makes proper positioning of the animal difficult. This probably accounts for the variation in the figures of the entire animal given by various authors. The armature of the distal segment of the first let has not hitherto been illustrated correctly. The basal segment of the maxilliped has a small process. Humes has illustrated the claws of leg four with crenate wings. I find the wings normal.

## **Sciaenophilus tenuis** (van Beneden)
(Fig. 136)

*Caligus* (*Sciaenophilus*) *tenuis* van Beneden, 1852, p. 464, Bassett-Smith, 1896, p. 156 ; Scott, T. & A. 1913. p. 63, pl. 40, figs. 1-6 ; Margolis *et al.*, 1975, p. 78.

*Sciaenophilus tenuis* Pillai, 1961, p. 115, fig. 16 ; Yamaguti, 1963, p. 66, pl. 85, fig. 2.

*Remarks.*—Cephalothorax small, circular, with low frontal plates and small lunules, postero-median lobe projecting. Posterior sinuses wide open. Fourth segment fused with genital segment and the whole considerably elongated and gradually widening, posteriorly wider than cephalothorax. Abdomen very long, one and a half times the rest of the body, apparently two-segmented, distal segment very short. Caudal rami oblong.

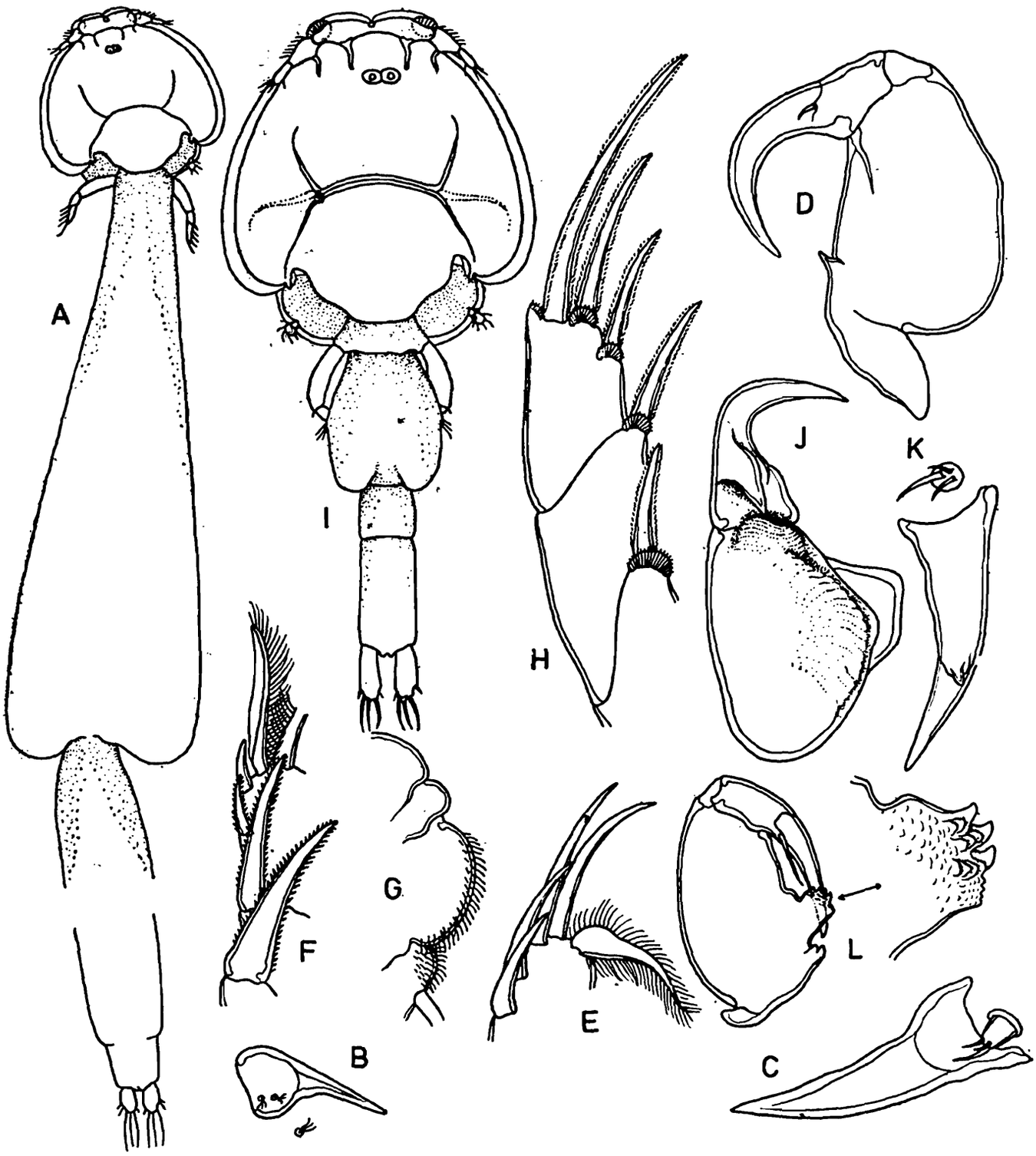


Fig. 136. *Sciaenophilus tenuis* (van Beneden) : A-H, Female. A, female, dorsal view ; B, post-antannal process ; C, post-oral process and maxillule ; D, maxilliped ; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 4. I-L Male. I, male, dorsal view ; J, antenna ; K, post-antennal process and maxillule ; L, maxiliped.

Post-antennal process a short claw. Post oral process long and narrow, an apically acute claw. Maxilla with short claws. Maxilliped massive, basal segment large, with sharp proximal process, distal segment slender, strongly curved.

First leg slender, distal segment with smooth slender slightly curved claws, spine-like seta smooth, as long as third claw but stouter, ventral setae normal. Claws on exopod of second leg serrated, first segment of endopod unarmed, others with stiff setules. Basal claw of exopod of third leg short, winged. Fourth leg four-segmented, basal segment broad, apical claw one and a half times as long as the subapical.

*Length.*—16.6 mm.

*Male.*—Frontal plates somewhat projecting, postero-median lobe about three times as broad as lateral lobes. Fourth segment large, clearly demarcated. Genital segment short. Abdomen two-segmented, basal segment shorter. Caudal rami large.

Second segment of antenna stout, with a large adhesion pad, distal segment with broad base and short claw bent at right angles, accessory claw stout and recurved. Post-antennal process with wide base and narrow straight, pointed claw, post-oral process curved, with small accessory process. Basal segment of maxilliped with two processes, first cut into two large teeth, second broad, with several transverse rows of tubercles.

*Length.*—3.2 mm.

*Host.*—*Sciaena aquila*, *Umbrina cirrosa*.

*Distribution.*—Atlantic, Mediterranean, Indian Ocean (Kerala).

## Genus **Parechetus** Pillai

*Parechetus* Pillai, 1962c, p. 287 ; Kirtisinghe, 1964, p. 74 ; Cressey, 1967d, 0. 4.

*Diagnosis.*—Cephalothorax like that of *Caligus*, very small. Fourth segment fused with genital segment, the complex thus formed

considerably elongated as in *Echetus*, its posterior third enlarged and gradually widening. Postero-lateral parts of genital segment produced into a pair of foliaceous apically rounded lobes remaining mostly on the ventral side. Abdomen one-or two-segmented, prolonged into a pair of wings extending horizontally outwards and backwards as in *Parapetalus*. Appendages generally as in *Caligus*.

Male unknown.

Parasites of teleosts (carangids).

Type species : *P. carangis* (Bassett-Smith).

*Discussion*.—This genus was created to accommodate *Caligodes carangis* Bassett-Smith (1898c) which differs from its congeners in that its abdomen like the genital segment is produced into petaliod lobes. The lobes of the genital segment of *Caligodes* are dorsal to the abdomen but ventral in *Parechetus*. This genus includes two species, *P. carangis* (Bassett-Smith) and *P. constrictus* Kirtisinghe (1964).

Heegaard (1945a) described *Caligodes alatus* which has a bell-shaped genital segment produced into two lobes disposed exactly as in *Parechetus*. Its abdomen is flattened. This species resembles *Parechetus* in the nature of the sternal fork and the fourth leg. The only difference is the absence of a long neck-like part in the genital segment. With slight modification of the generic definition this species can be included in *Parechetus*.

*Key to species of* **Parechetus**

1. Neck-like prolongation of genital segment short ..... *alatus* (Heegaard)
— Neck-like prolongation of genital segment long ..... .2

2. Swollen part of genital sement nearly as long as neck-like part ..... .*constrictus* Kirtisinghe
— Swollen part of genital segment shorter than neck-like part ..... .*caragis* (Bassett-Smith)

## **Parechetus carangis** (Bassett-Smith)
(Fig. 137)

*Caligodes carangis* Bassett-Smith, 1898c, p. 361, pl. 11, fig. 4 ; Yamaguit, 1963, pl. 51, fig. 4.
*Parechetus carngis* Pillai, 1961, p. 118, fig. 18 ; 1967d, p. 1601, fig. 97.

*Female.*—Cephalothorax nearly circular, lunules very small, postero-median lobe slightly broader than lateral lobes, projecting beyond the latter, lateral lobes curving inwards, nearly closing the posterior sinuses. Fourth segment as long as broad, demarcated from genital segment by only a constriction. Genital segment very long, about three and a half times as long as cephalothorax, anterior two thirds narrow, posterior one third swollen, broadening backwards and posteriorly produced into two petaloid lobes shifted to the ventral side, their dorsal edge strengthened by a ridge-like thickening. Abdomen about a quarter of the length of the genital segment, two-jointed, first segment laterally expanded into wings which extend backwards. Caudal rami small.

Distal segment of antennule long and slender. Antenna stout, second segment with a prominent hump. Post-antennal process a broad-based claw with prominent accessory process on its base. Post-oral process not observed. Maxillule with prominent nodule, one of the setae long. Claws of maxilla short and straight. Basal segment of maxilliped with a pair of backwardly curved hook-like processes. Sternal fork could not be studied properly since the tines are strongly curved.

Basipod of first leg armed with unusually large teeth, distal segment with a small spine on lower border instead of setae, spine-like seta short and slender, plumose, claws normal. First claw on exopod of second leg long, slanting downwards, second and third small, first segment of endopod partly hairy and partly spiny, others hairy. Rami of third leg placed close together, claw of exopod strongly curved, apron with large teeth. Fourth leg short but stout, four-segmented, basal segment as long as rest of the limb, claws subsimilar.

*Length.*—7.3 mm.

*Host.*—*Caranx ferdau.*

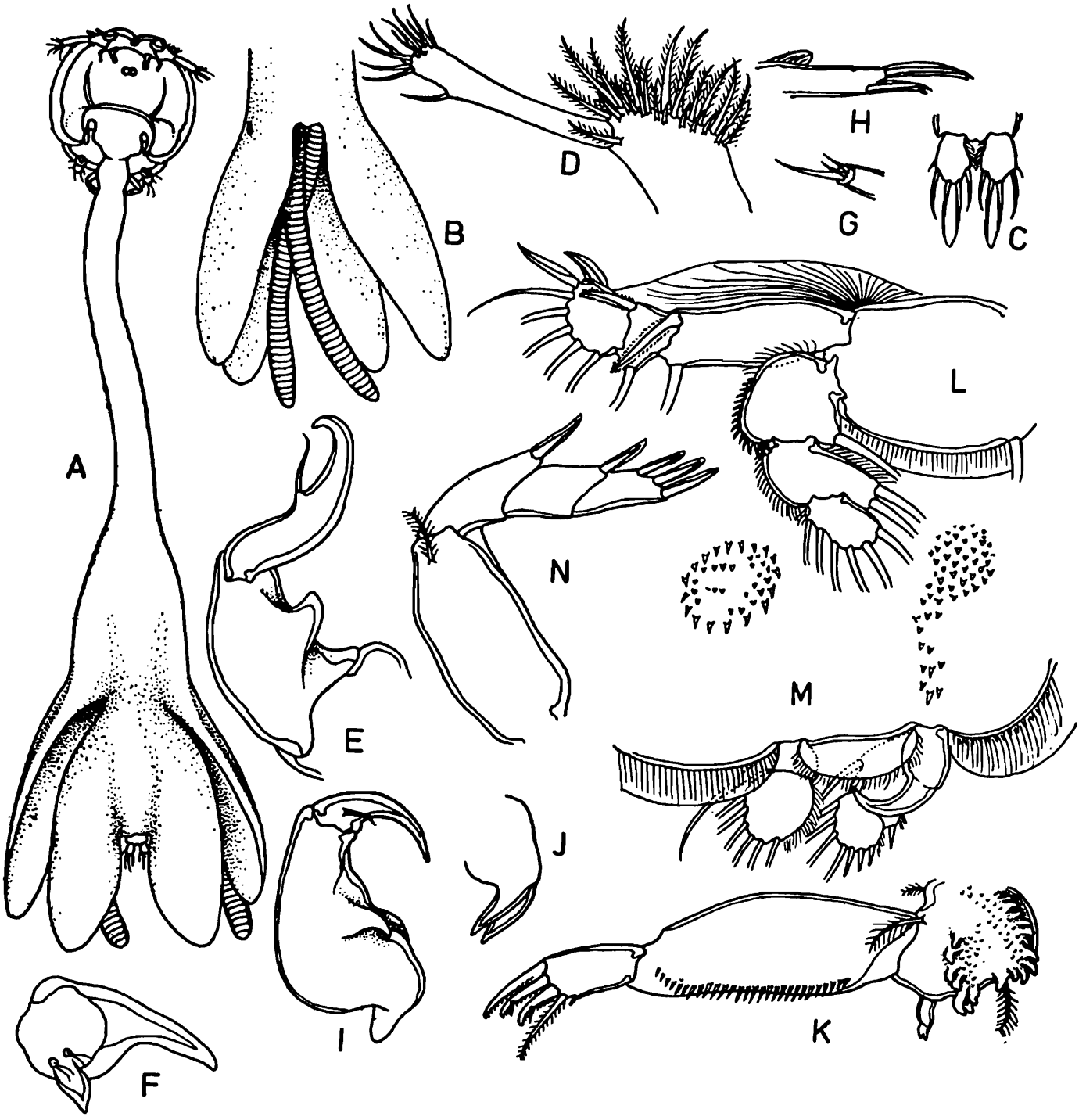


Fig. 137. *Parechetus carangis* (Bassett-Smith) ; A, female, dorsal view ; B, hind part of body, ventral view ; C, caudal rami ; D, antennule ; E, antenna ; F, post-antennal process ; G, maxillule ; H, maxilla ; I, maxilliped ; J, sternal fork ; K, leg 1 ; L, leg 2 ; M, leg 3 ; N, leg 4.

*Distribution.*—Aden, India (Kerala).

*Remarks.*—A detailed study of this species could not be made since I had only a single specimen. In the structure of the post-antennal process, maxilliped, sternal fork and the first leg all the

species of *Parechetus* show close similarity making the genus homogeneous. Unfortunately none of the species has so far been described satisfactorily.

### **Parechetus constrictus** Kirtisinghe

*Parachetus constrictus* Kirtisinghe, 1964, p. 74, figs. 81-86.

*Female.*—Cephalothorax comparatively small, equal in length and width. Frontal plates moderately projecting, with small lunules. Postero-median lobe projecting beyond lateral lobes, nearly twice as broad as the latter, psterior sinuses fully open. Dorsal transverse rib placed far back. Fourth segment elongated and demarcated from genital segment by a partition. Genital segment with long anterior neck, further on gradually widening and posteriorly produced into a pair of lateral wings. Genital sement continued into the abdomen, latter produced into a pair of dorsal wings, leaving only the hind end of the abdomen free. Caudal rami with four setae. Egg tubes overreaching the abdominal wings.

*Length.*—5.8 mm.

*Host.—Caranx melampygus.*

*Distribution.*—Sri Lanka.

*Holotype.*—Female in the Colombo Museum.

*Remarks.—P. contrictus* closely resembles *P. carangis* but according to Kirtisinghe its long neck-like fourth segment is set off from the genital segment by a distinct septum. His figure 81 showing the entire animal is curious in that the cephalothorax is shown in the dorsal aspect and the genito-abdominal part in the ventral. Kirtisinghe definitely says that the abdominal wings are dorsal and the wings of the genital segment ventral. The position of the egg tubes makes this clear. It seems that, while mounting, the specimen got twisted in the middle of the long neck making the hind part upside down cerating a false partition. If this is so *P. constrictus* will turn out to be the same as *P. carangis.* Unfortunately this question must be eft open since I did not succeed in securing Kirtisinghe's specimen for study.

## Genus **Synestius** Stp. & Lutk.

*Synestius* Stp. & Lutk., 1861, p. 364 ; Wilson, 1905a, p. 533 ; Yamaguti, 1963 p. 67 ; Cressey, 1967d, p. 4.

*Diagnosis.*—Cephalothorax like that of *Caligus*. Genital segment enlarged, subequal to cephalothorax in size, posteriorly produced into two pairs of elongated club-shaped processes, dorsal pair nearly twice as long as ventral. Fourth segment small, but distinct, forming a connection between cephalothorax and genital segment. Abdomen long, club-shaped and two-segmented, longer than processes of genital segment. Appendages as in *Caligus*.

Male showing the same type of sexual dimorphism as in *Caligus*.

Parasites of teleosts.

Type species : *S. caliginus* Stp. & Lutk.

### **Synestius caliginus** Stp. & Lutk.
(Fig. 138)

*Synestius caliginus* Stp. & Lutk., 1861, p. 364, pl. 6, fig. 11 ; Gnanamuthu 1950e, p. 253, figs .1-3 ; Shen, 1957b, p. 356, pl. 11 ; Pillai, 1961, p. 117, fig. 17 ; Yamaguti, 1963, p. 67, pl. 87, fig. 2.

*Female.*—Cephalothorax large, nearly circular, lunules small, postero-median lobe twice as broad as lateral lobes, not projecting. Fourth segment broad. Genital segment swollen, as broad as cephalothorax, antero-laterally rounded, posteriorly produced into two pairs of digitiform processes. Dorsal processes as long as abdomen, ventral ones shorter, nearly half the length of dorsal. Abdomen longer than cephalothorax and genital segment, two-segmented, first segment widening backwards, seond very short. Caudal rami longer than broad.

Distal segment of antennule long. Antenna very slender, second segment with dorsal hump, third slender and strongly curved. Post-antennal process a chitinised plate with short accessory process, post-oral small and cylindrical. Outer lobe of second segment of maxilla large, claws short, with broad serrate wings.

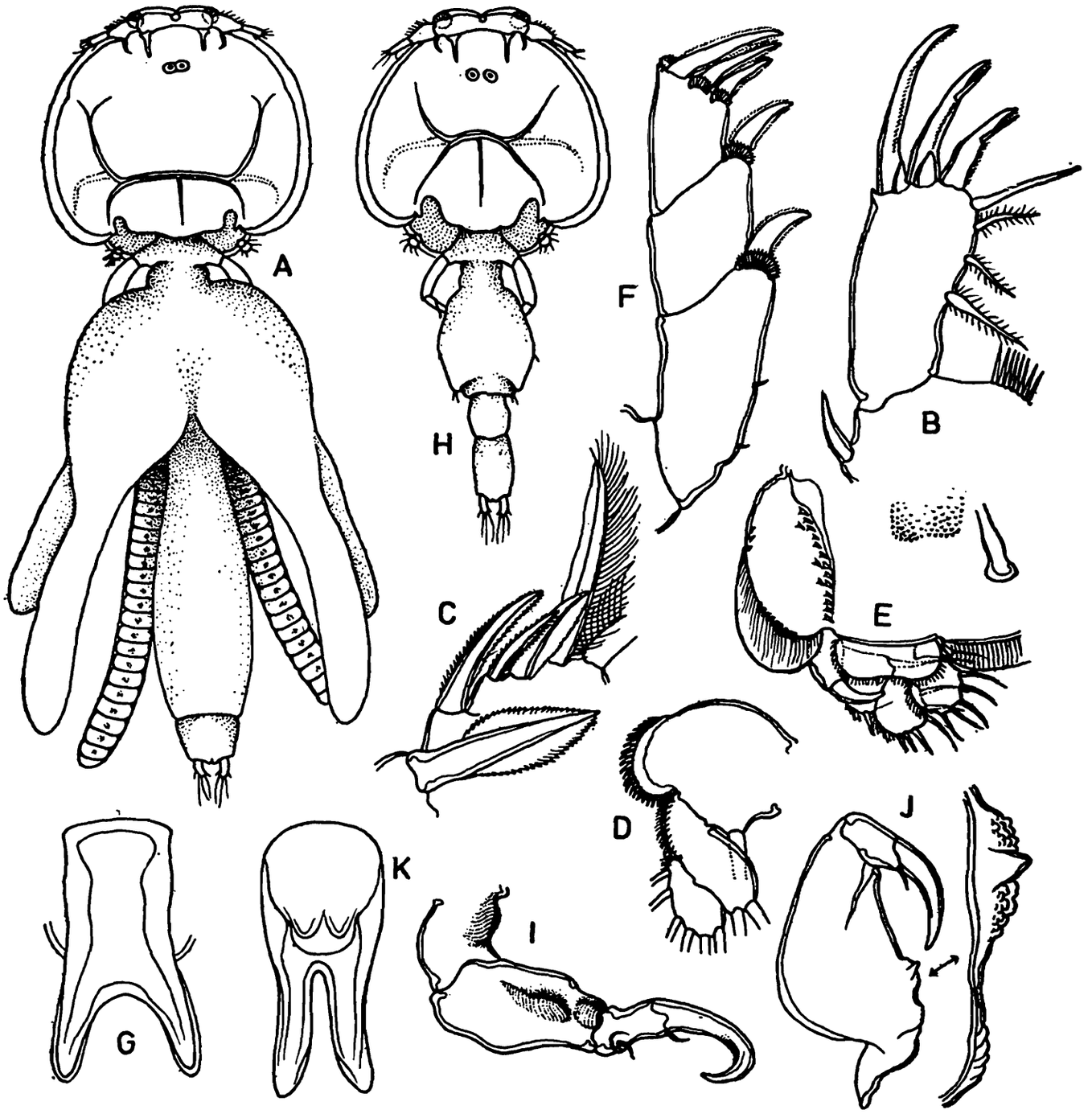


Fig. 138. *Synestius caliginus* Stp. & Lutk. : A-G Female. A, female, dorsal view ; B, leg 1 ; C, leg 2, exopod ; D, same, endopod ; E, leg 3 ; F, leg 4 ; G, sternal fork. H-K, Male. H, male, Dorsal view ; I, antenna ; J, maxilliped ; K, sternal fork.

Basal segment of maxilliped stout, with an acute tooth. Limbs of sternal fork short, slightly diverging.

Basipod of first leg spiny, distal segment with three small ventral setae, spine-like seta naked, claws spiny, second and third with

accessory process. First claw of exopod of second leg with broad serrate wings, second and third with narrow wings, first seta claw-like, basal segment of endopod very large, its distal part produced, with a row of short teeth, other segments hairy. Basal claw of exopod of third leg strongly curved. Fourth leg four-segmented, basal segment broad, first two claws stout, last three slender.

*Length.*—4.7 mm.

*Male.*—Cephalothorax broader behind, frontal plates prominent, median lobe narrower, fourth segment longer. Genital segment with anterior neck, abdomen short, two-segmented. Antenna slender and irregular, first and second segments with adhesion pad, third recurved. Basal segment of maxilliped stout, with a corrugated bulge followed by a strong tooth, flanked by clusters of tubercles. Limbs of sternal fork longer than in female, basally converging and distally diverging, producing a very characteristic shape.

*Length.*—3.4 mm.

*Host.*—*Parastromateus niger*, *Pampus argenteus*, *Stromatoides sinensis*.

*Distribution.*—India (Kerala, Madras), Sri Lanka, China.

## Genus **Abasia** Wilson

*Abasia* Wilson, 1908a, p. 612 ; Yamaguti, 1963, p. 78 ; Pillai, 1963d, p. 1,
? *Alicaligus* Shiino, 1965b, p. 55.

*Diagnosis.*—Cephalothorax genital segment and abdomen enlarged, subequal in size. Cephalothorax antero-medially produced into a rostrum carrying the frontal plates and the inconspicuous lunules. Lateral parts folded downwards. Dorsal transverse rib shifted back. Abdomen two-segmented, first segment enlarged, second small. Basal segment of antennule with stout pectinate setae. Antenna small. Post-antennal process absent, post-oral small. Maxillule well developed. Maxilla very small. Maxilliped massive. Sternal fork absent. Thoracic appendages as in *Caligus* but reduced in size and armature.

Cephalothorax of male similar to that of female. Genital segment and abdomen not enlarged, latter two-segmented, first segment small. Antenna well developed, subchelate. Post-antennal process well developed.

Parasites of teleosts (lizard fishes).

Type species : *A. pseudorostris* Wilson.

*Discussion.*—Yamaguti (1963) placed this genus in subfamily Lepeophtherinae, obviously relying on the definition of the genus by Wilson. Pillai (1963d) showed that *Abasia* possesses lunules though very inconspicuous. This genus should come under Caliginae.

*Alicaligus* Shiino closely resembles *Abasia.* As in *Abasia* the sternal fork is absent in both sexes, the post-antennal process is absent in female but well developed in male. The legs show identity except that in *Alicaligus* the endopod of leg three is one-jointed but two-jointed in *Abasia.* As I could not consult the original description of *Alicaligus* I am reluctant to take a decision. Its inclusion in the following key is provisional.

*Key to species of* **Abasia**

| | | |
|---|---|---|
| 1. | Rostal process conical | .*pseudorostris* Wilson |
| — | Rostral process rectangular | .2 |
| 2. | Endopod of leg three reduced to a small lobe | .*tripartitus* (Shiino) |
| — | Endopod of leg three two-jointed | .*platyrostris* Pillai |

## **Abasia platyrostris** Pillai
(Fig. 139)

*Abasia platyrostric* Pillai, 1963d, p. 5, figs. 2-3 ; 1967d, p. 1602, fig. 101.

*Female.*—Cephalothorax broader than long, lateral parts folded downwards. Frontal plates short, placed on a short rostral prolongation. Lunules very small. Antero-lateral parts of cephalothorax shoulder-like, postero-lateral rounded. Median lobe more than twice as broad as lateral lobes. Dorsal transverse rib shifted

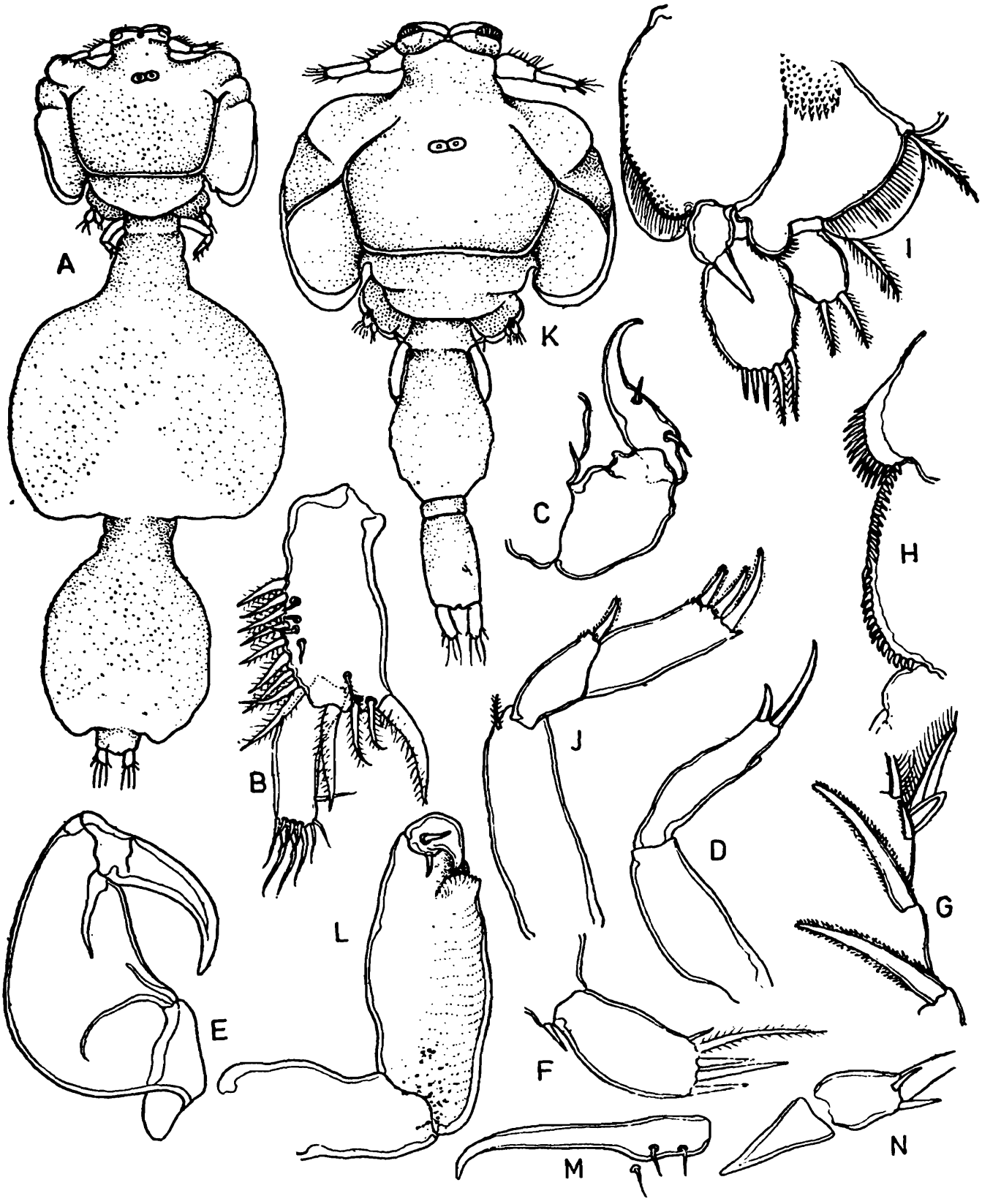


Fig. 139. *Abasia platyrostric* Pillai : A-J, Female. A, female, dorsal view ; B, antennule ; C, antenna ; D, maxilla ; E, maxilliped ; F, leg 1 ; G, leg 2, exopod ; H, same, endopod ; I, leg 3 ; J, leg 4. K-N, Male. K, male, dorsal view ; L, antenna ; M, post-antennal process ; N, post-oral process and maxillule.

far back to the base of the median lobe. Fourth segment distinct. Genital segment swollen, longer and broader than cephalothorax, with anterior neck. Abdomen enlarged, much narrower than genital segment, anteriorly constricted, distal part free of expansion.

Antennule stout, setae on basal segment stout and pectinate, lower distal seta particularly so. Antenna slender and weak, third segment with swollen base carrying two spines. Post-antennal process absent, post-oral process very small. One of the seta of maxillule very stout. Maxilla small, distal segment with very small outer lobe, claws short, stout and dissimilar. Maxilliped massive. Sternal fork absent.

Distal segment of first leg elongated, ventral border with a single spine. Spine-like seta very long, pectinate. Claws long and simple, second longest. First two claws on exopod of second leg similar, third small, basal segment of endopod with a row of long slender spines, second with a row of sharp teeth. Apron of third leg reduced in size, basal claw of exopod with stout base, claw slender, straight and bent inwards, endopod two-jointed, apron having a rounded velum partly covering the overlapping rami. Fourth leg three-jointed, short and stumpy, with four claws.

*Length.*—3.8 mm.

*Male.*—Rostral prolongation more prominent, frontal plates deeper. Genital segment pear-shaped, abdomen two-segmented, narrow, first segment very short. Caudal rami much longer than broad. First two segmets of antenna elongated, second segment with large adhesion pad, its distal inner part produced into a serrate lobe against which the short claw-like third segment closes, base of the claw swollen, with two spines. Post-antennal process long, slender and apically curved.

*Length.*—1.5 mm.

*Host.—Saurida tumbil, Synodus indicus.*

*Distribution.*—India (Kerala).

*Holotype* Female and *allotype* male in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2141/2 & C2142/2.

## Genus **Caligodes** Heller

*Caligodes* Heller, 1868, p. 180 ; Wilson, 1905a, p. 533 ; Yamaguti, 1963, p. 63 ; Cressey, 1967d, p. 4.

*Diagnosis.*—Cephalothorax small, fourth segment more or less fused with genital segment and the complex thus formed considerably elongated and steadily broadening backwards and posterolaterally produced into two large foliaceous processes nearly as long as the combined length of the fourth and genital segments and longer than the abdomen. Abdomen long and cylindrical, apparently one-segmented and ventral to processes of genital segment. Caudal rami very small. Appendages generally as in *Caligus* but each showing some characteristic difference. First and fourth legs reduced in size and armature.

Male unknown.

Parasites of teleosts (needle fishes).

Type species : *C. laciniatus* Heller.

*Discussion.*—Yamaguti placed five species, *C. laciniatus* Heller (1868), *C. alatus* Heegaard (1945a), *C. carangis* Bassett-Smith (1898c), *C. lamarckii* Quidor (1913) and *C. megacephalus* Wilson (1905a) under this genus. Pillai (1961) removed *C. carangis* and *C. alatus* to *Parechetus*. *C. laciniatus* alone occurs in Indian waters.

### **Caligodes laciniatus Heller**
(Fig. 140)

*Caligodes laciniatus* Heller, 1868, p. 180 ; Kirtisinghe, 1937a, p. 439, figs. 30-40 ; Rangnekar, 1959, p. 49, fig. 3 ; Pillai, 1961. p. 114, fig. 15 ; Yamaguti, 1963 p. 63, pl. 51, fig. 1 ; Cressey and Collette, 1970, p. 378, figs. 133-195.

*Female.*—Cephalothorax comparatively small and rounded, frontal plates and lunules small, mdeian lobe produced and demarcated from fourth segment by a constriction. Fourth segment fused

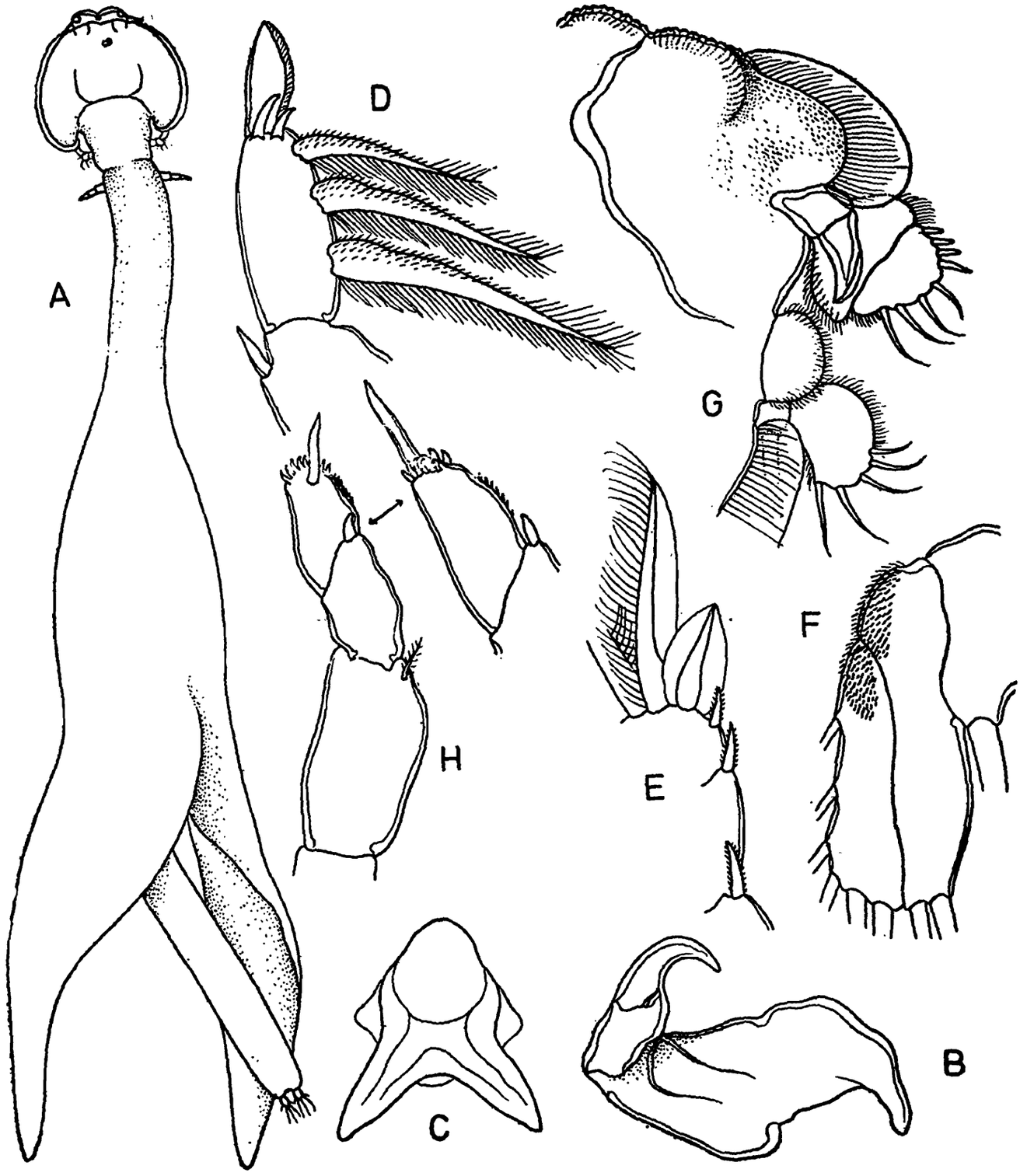


Fig. 140. *Caligodes laciniatus* Heller : A, female, dorsal view ; B, maxilliped ; C, sternal fork ; D, leg 1 ; E, leg 2, exopod ; F, same, endopod ; G, leg 3 ; H, leg. 4.

with genital segment, its position indicated only by the insertion of the fourth legs. Genital segment two and a half to three times as log as broad, broadening backwards, postero-laterally produced

into a pair of large foliaceous processess, as long as the genital segment, overlapping at their base and narrowing distalwards. Abdomen almost as long as genital segment, distally bilobed. Caudal rami minute.

Antenna robust, basal segment with a short process, distal strongly curved. Post-antennal process a simple plate, post-oral short but broad, claw curved, with an adhesion pad. Maxilla very small, subapical claw straight and spiny, apical curved, with narrow wing. Maxilliped stout, with short well curved distal segment. Sternal fork with strongly diverging limbs.

First leg small, basipod with large patch of denticles, distal segment of exopod with very stout ventral setae, externally pectinate and internally hairy, spine-like seta absent, first claw very large, swollen, with ventral flange, the whole rather flattened, second and third small and naked. Claws on exopod of second leg small and subsimilar, spiny, first seta with broad wings, endopod segments partially fused, second and third with patches of spinules. Apron of third leg irregular, outer part spiny and with two large adhesion pads, basal claw of exopod short but stout, externally flanged, rami profusely hairy. Fourth leg stumpy, three-segmented, with reduced armature, second segment with a short naked claw, inner middle part of third segment with a row of spinules, distal border with three spines, first two small, third long, all naked. At the base of the long spine is a curved row of spines.

*Length.*—5-10 mm.

*Host.—Tylosurus crocodilus, T strongylurus, T leiurus, T contraini, T acus, T choram, Ablennes hians, Strongylura leiura, Platybelone argalus, Lhotskia gavialoides.*

*Distribution.*—Circumtropical (Indian, Pacific and Atlantic oceans).

## Subfamily LEPEOPHTHERINAE Yamaguti

*Diagnosis.*—Cephalothorax as in Caliginae. Frontal plates without lunules. Genital segment normally developed or highly

enlarged and with or without processes. Abdomen one or two segmented, long or short. Post-antennal process simple or forked may be absent. Post-oral process simple or with accessory processes. Sternal fork present or absent. Legs generally as in Caliginae (first leg biramous in *Pupulina*).

Male showing dimorphism as in Caliginae.

Type genus : *Lepeophtheirus* Nordmann.

*Discussion.*—This subfamily as treated here differs from that of Yamaguti in that *Abasia* Wilson and *Heniochophilus* Yamaguti and Yamasu have been excluded. *Abasia* has lunules and hence must come under Caliginae. *Heniochophilus* closely resembles *Anuretes* and is placed in Anuretinae.

The three genera described under this subfamily differ so widely from one another that the subfamily lacks homogenity. Each can be placed in a separate subfamily.

*Key to genera of* LEPEOPHTHERINAE

| | | |
|---|---|---|
| 1. | Sternal fork absent, first leg biramous | .**Pupulina** van Beneden |
| — | Sternal fork present, first leg uniramous | .2 |
| 2. | Cephalothorax longitudinally folded | .**Hermilius** Heller |
| — | Cephalothorax not folded | .**Lepeophtheirus** Nordmann |

## Genus **Hermilius** Heller

*Hermilius* Heller, 1868, p. 186 ; Barnard, 1955, p. 100 ; Pillai, 1963a, p. 179 ; Yamaguti, 1963, p. 82 ; Kabata, 1964a, p. 617.

*Diagnosis.*—Cephalothorax broader than long, folded along median longitudinal line. Dorsal ribs conspicuous. Frontal plates indistinct, slanting towards the middle, lunules absent. Fourth segment small, partially overlapped by adjacent parts. Genital segment enlarged. Abdomen small, one to two-segmented. Caudal rami with setae modified into irregular spines.

Antennule with pectinate setae. Antenna very large, three-to four-jointed, distal segment long and falcate, with accessory claw.

Post-antennal process absent, post-oral long and slender. Maxilla very small. Maxilliped long and slender. Sternal fork present, often deformed. Thoracic appendages generally as in *Caligus*. Vestigial endopod of first leg usually large and spinulose claws on distal segment long, with ventral firill, spine-like seta reduced to a conical process. Apron of third leg reduced in size. Fourth leg with reduced segmentation and armature.

Male with cephalothorax not folded, lateral parts bent downwards, frontal plates distinct, normally oriented. Fourth thoracic segment large. Genital segment not swollen. Caudal rami with normal setae. Antenna more strongly developed than in female. Maxilliped stout.

Parasites of teleosts (cat fishes).

Type species : *H. pyriventris* Heller.

*Discussion.*—This genus contains six species, *H. pyriventris* Heller (1868), *H. longicornis* Bassett-Smith (1898b), *H. helleri* Pillai (1963a), *H. armatus* Capart (1959), *H. youngi* Kabata (1964a) and *H. tachysuri* Pillai and Natarajan (1977). Kabata is of the view that *H. armatus* is a synonym of *H. pyriventris*.

*Hermilius* spp. are quite common on the gills of cat fishes but their records are very few, all from the Indo-West Pacific. *Hermilius* provides a good example of the morphological changes resulting from the change of habitat, a unique example among caligids.

*Key to species of* **Hermilius**

1. Antenna with a partition beyond the accessory claw .2
— Antenna without partition beyond the accessory claw .4

2. Lateral borders of genital segment parallel .3
— Lateral borders of genital segment posteriorly convergent *.helleri* Pillai

3. Genital segment longer than cephalothorax *.pyriventris* Heller
— Genital segment shorter than cephalothorax *.tachysuri* Pillai and Natarajan

4. Accessory claw of antenna without setule, second segment of maxilliped with subapical tooth — *youngi* Kabata
— Accessory claw of antenna with setule, second segment of maxilliped without subapical tooth — *.longicornis* Basett-Smith

## **Hermilius pyriventris** Heller
(Fig. 141-142)

*Hermilius pyriventris* Heller, 1868, p. 187, pl. 18, fig. 1 ; Pillai, 1963a, p. 181 figs. 1 A-D ; Yamaguti, 1963, p. 82, pl. 89, fig. 1 ; Barnard, 1955, p. 100 ; Kabata, 1964a, p. 617 ; Cressey, 1974, p. 236, figs. 1-22.

*Female.*—Cephalothorax large, broader than long, postero-median lobe comparatively narrow, only slightly broader than lateral lobes and only slightly projecting beyond the latter, posterior sinuses shallow and wide open. Frontal plates narrow. Fourth segment very small, fused with genital segment, latter swollen, long, narrower behind. Abdomen short, two-jointed, first segment longer. Caudal rami longer than broad, with three plumose setae, apical setae stout, modified, median very large, distally drawn out.

Antennule with large basal segment, distal short, former with stout pectinate setae. Antenna slender and long, first segment short, second corrugated on inner side, third segment very long, with a proximal seta and a stout accessory claw in the middle, beyond the latter there is a distinct partition making the appendage four-jointed, distal part claw-like, apically recurved. Post-antenal process absent. Post-oral process long and slender, base internally produced into a curved process. Maxilla small, claws stout, short and stumpy, greatly unequal and not separated by septa. Maxilliped slender and long, distal segment with oblique distal partition demarcating an unguis, with a blunt tooth and a seta on the septum, unguis with inner subapical tooth. Sternal fork with indistinct base, limbs conical, apically acute and diverging.

Basipod of first leg spiny, upper distal seta long and pectinate, vestigial endopod covered with spinules, distal segment of exopod with three large ventral setae, claws long, second twice as long as first and third one and a half times the length of second, all apically curved, with long narrow ventral wing. First claw of exopod of

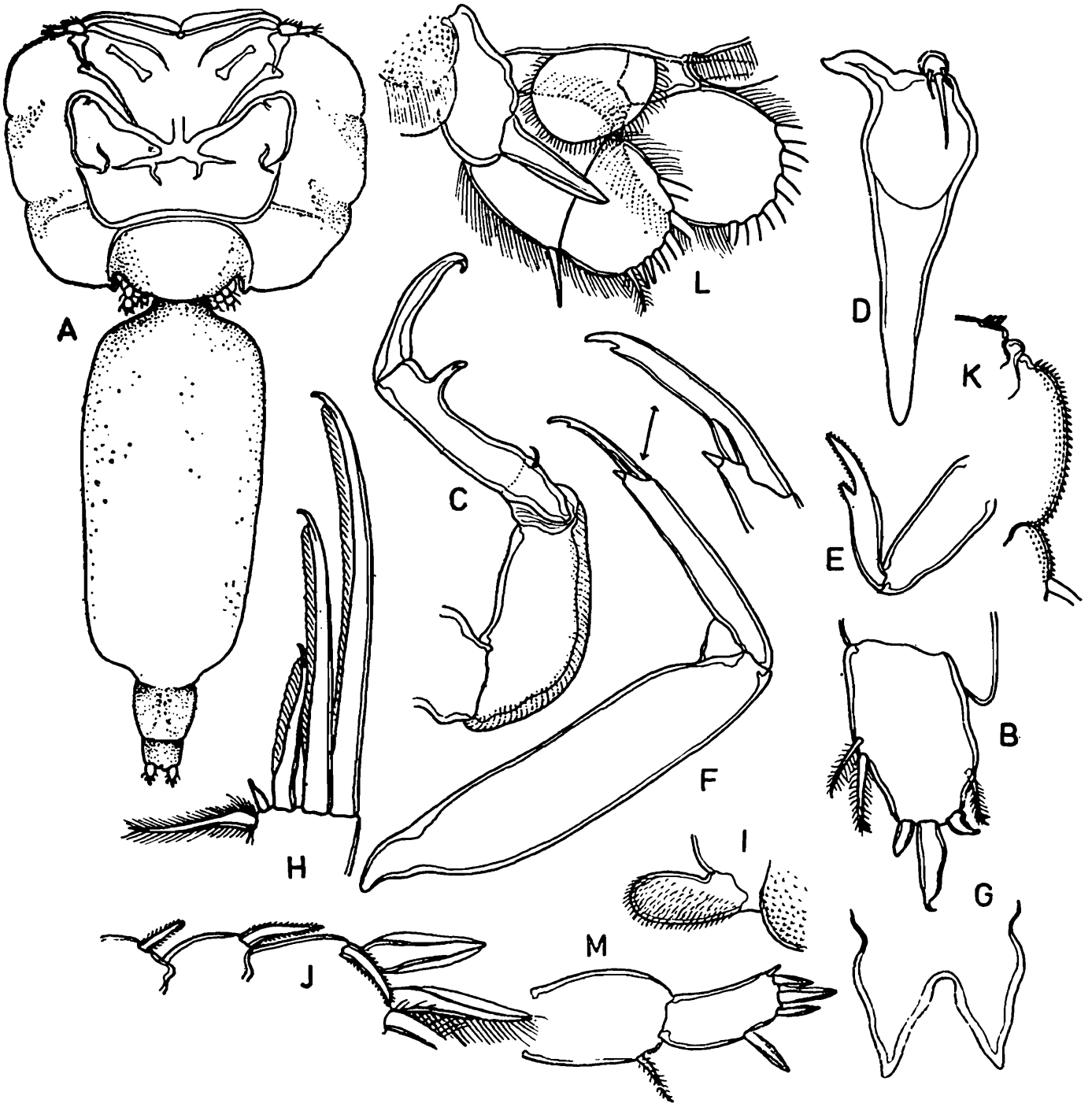


Fig. 141. *Hermilius pyriventris* Heller ; A, female, dorsal view ; B, caudal ramus ; C, antenna ; D, post-oral process and maxillule ; E, maxilla ; F, maxilliped ; G, sternal fork ; H, leg 1 ; I, same, vestigial endopod ; J, leg 2, exopod ; K, same, endopod ; L, leg 3 ; M, leg 4.

second leg small, second and third larger, third curved downwards, first two setae winged. Basal segment of endopod with four to five short spines, second and third segments with three to four rows of small denticles. Apron of third leg reduced in size, outer part spiny, basal claw of exopod with swollen base, spine straight, bent inwards,

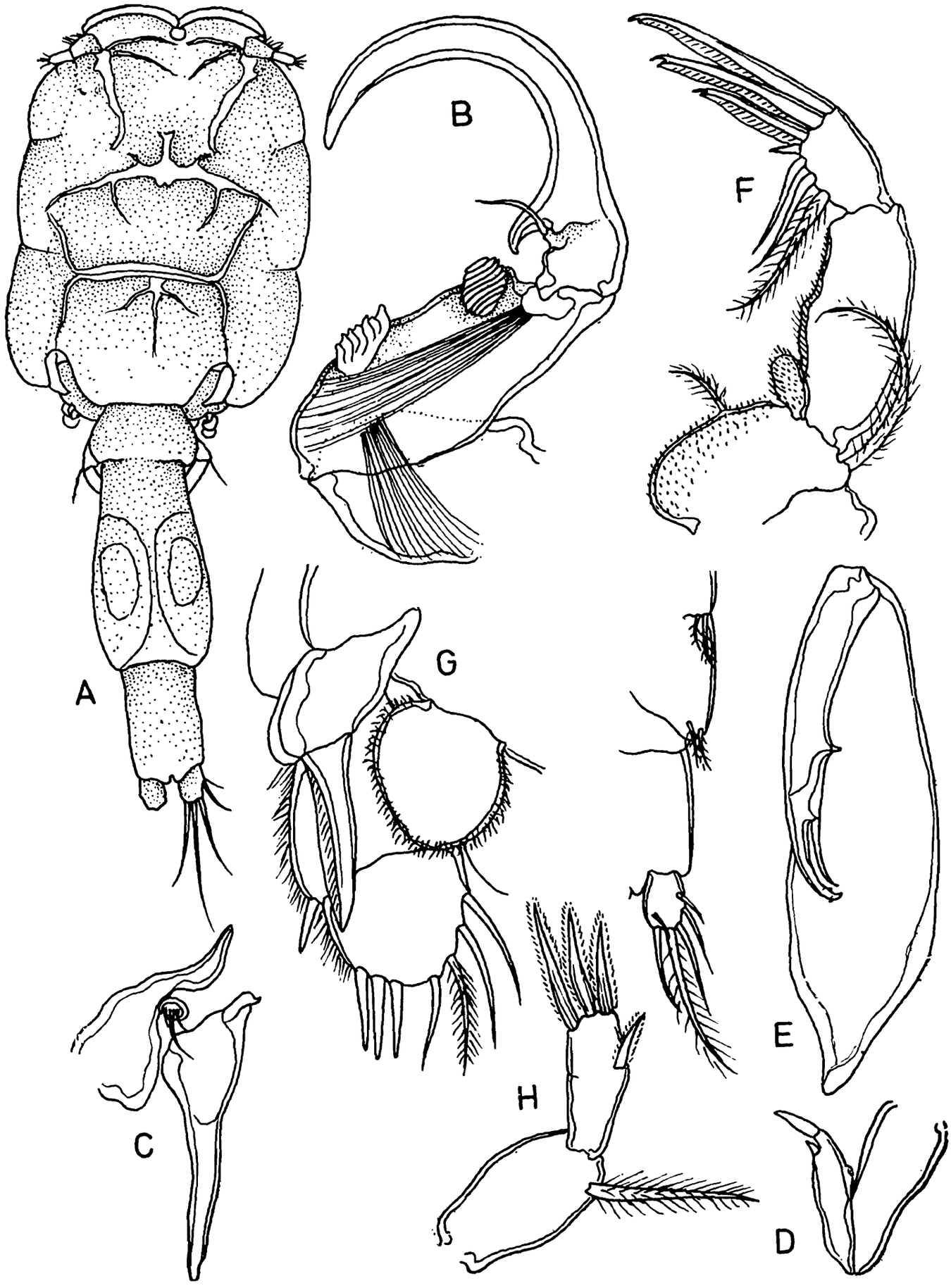


Fig. 142. *Hermilius pyriventris* (contd.) : A, male, dorsal view ; B, antenna ; C, post-antennal process and maxillule ; D, maxilla ; E, maxilliped ; F, leg 1 ; G, leg 3 ; H, leg 4 ; I, legs 5-6 and caudal ramus.

rami heavily hirsute, overlapping and overlapped by the velum. Fourth leg very much reduced, a two-jointed stump, basal segment with pectinate lower distal seta, second segment with one ventral and three distal winged claws and a small denticle.

*Length.*—3.5 mm.

*Male.*—Cephalothorax longer than broad, with parallel sides due to the folding of the lateral parts downwards. Frontal plates large, normally placed. Postero-median lobe twice as broad as lateral lobes. Fourth segment large, broadening backwards. Genital segment much longer than broad, widening backwards. Abdomen one-jointed and stout. Caudal rami with six plumose setae.

Appendages generally as in female. Second segment of antenna large, with two inner corrugated projecting pads, third segment much stouter than in female, with proximal inner seta followed by a slightly curved conical process, no accessory claw or distal partition as in female. Basal segment of maxilliped stouter than in female. Fourth leg better developed than in female.

*Length.*—1.5 mm.

*Host.—Arius acutirostris, A. hendeloti, Pseudarius platystomus, Tachysurus feliceps, Netuma macrocephalus, N. thalassinus.*

*Distribution.*—Java, Philippines, India (Kerala), Mauritania, Kenya, South Africa.

*Remarks.*—Hameed and Pillai (1972a) described the male of *Hermilius* collected along with females of *H. pyriventris*. Since the distal segment of its antenna did not have the partition characteristic of that of the female they did not assign the male to *H. pyriventris*. Cressey (1974) described the male of *H. pyriventris* which is exactly the same as ours.

*Hermilius* species are indeed very much alike and are distinguished by the extent of the degeneration of the various appendages, besides the character of the antennae. The female of *H pyriventris* has a four-jointed antenna whereas the male has a

three-jointed antenna. This eliminates one of the main distinguishing characters of *Hermilius* spp. It is likely that the males of all species of *Hermilius* have three-jointed antennae, irrespective of the condition in the female.

### **Hermilius longicornis** Bassett-Smith
(Fig. 143)

*Hermilius longicornis* Bassett-Smith, 1898b, p. 79, pl. 3, fig. 2 ; Pillai, 1963a, p. 182, fig. 2; Rangnekar, 1963, p. 80, figs. ; Yamaguti, 1963, p. 83 ; Kirtisinghe, 1964, p. 76, fig. 88 ; Kabata, 1964a, p. 617.
*Hermilius pyriventris* Pillai, 1961, p. 123, fig. 21 (nec Heller, 1868).

*Female.—Generally resembling H. pyriventris.* Median lateral constriction of cephalothorax deeper. Frontal plates very low. Postero-median lobe very short, not reaching the level of the lateral lobes, narrower than latter. Fourth segment overlapped by the highly swollen genital segment, latter one and a half times as long as broad, with rounded corners, antero-laterally produced forwards making the anterior border trilobed. Abdomen very small, two-segmented, first segment twice as long as second, parallel sided. Caudal rami longer than broad, narrowing to the rounded tip and armed with two outer setae and three apical ones, median apical seta stout, all the setae plumose.

Antennule as in *H. pyriventris.* Antenna stouter less irregular, second segment broader but shorter than in *H. pyriventris*, third segment a long falcate claw with a small basal process carrying a small setule and a stout accessory claw. Post-oral process stouter than in *H. pyriventris.* Maxilla better developed, claws winged. Maxilliped shorter but stouter than in *H. pyriventris*, distal segment shorter, unguis without subapical spine. Sternal fork quite different, base clearly evident, rami flattened and parallel, distally broadened, apex rounded.

Apex of the claws of first leg free of the ventral wing, longer and more curved. Claws on exopod of second leg sub-similar, third not bent downwards. Basal claw of exopod of third leg much different from that of *H. pyriventris*, base with small outer wing, claw curved inwards, with long narrow outer flange, outer spine on basal segment of exopod reaching beyond distal segment, velum

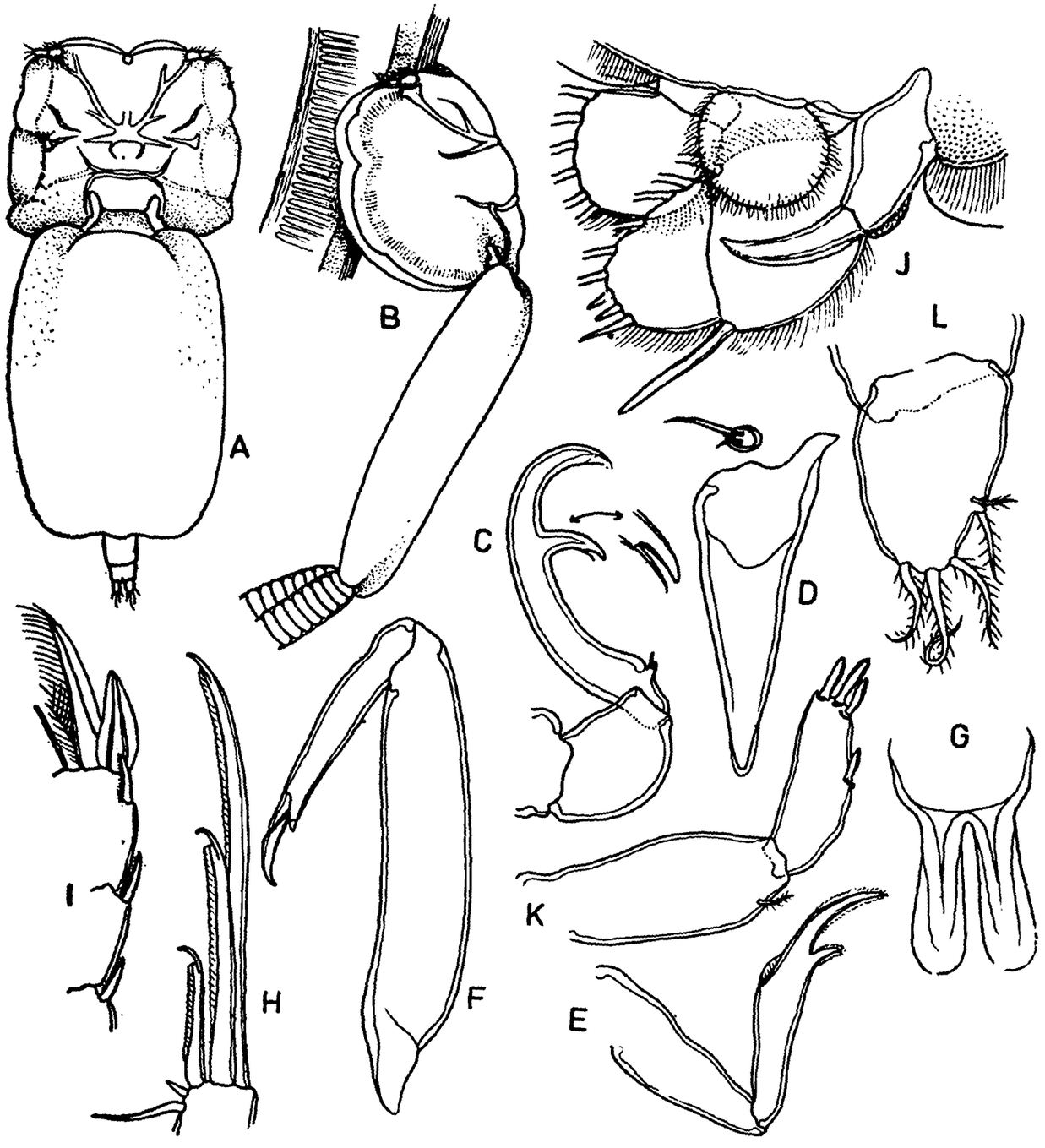


Fig. 143. *Hermilius longicornis* Basett-Smith : A, female, dorsal view ; B, same, lateral view ; C, antenna ; D, post-antennal process and maxillule ; E, maxilla ; F, maxilliped ; G, sternal fork ; H, leg 1 ; I, leg 2, exopod ; J, leg 3 ; K, leg 4 ; L, caudal ramus.

very large. Basal segment of fourth leg longer than distal, distal with four subsimilar feebly winged claws, quite different from that of *H. pyriventris*.

*Length.*—5.0 mm.

*Host.*—*Arius acutirostris*, *A. dussumieri*, *Ariodes dussumieri*.

*Distribution.*—Sri Lanka, India (Kerala, Bombay).

**Hermilius helleri** Pillai
(Fig. 144)

*Hermilius helleri* Pillai, 1963a, p. 185, fig. 3 ; 1967d, p. 1604, fig. 105.

*Female.*—Closely resembling *H. pyriventris* but showing easily recognisable specific differences. Frontal plates much narrower. Genital segment produced forwards, completely hiding the fourth segment and even a part of the median lobe of cephalothorax, its anterior border trilobed as in *H. longicornis*. At two-thirds distance from base genital segment abruptly constricted and further on narrowing, distal border nearly transverse. Abdomen short, two-segmented, first segment overlapped by genital segment. Caudal rami short, oblong, apical three setae modified as in *H. pyriventris*.

Antenna almost as in *H. pyriventris* but accessory claw with a trigger-like long seta. Post-oral process more slender than in *H. pyriventris*. Distal segment of maxilliped with a median tooth-like projection in addition to the tooth on the septum demarcating the unguis. Limbs of sternal fork more diverging.

First claw of exopod of second leg small, second and third subsimilar, both bent downwards, endopod segments two and three with stiff setules. Basal claw of exopod of third leg stout, its base externally expanded, with broad wing. Claw inclined inwards, externally flanged. Fourth leg with basal segment stouter than distal, latter with four claws, increasing in length.

*Length.*—4.0 mm.

*Host.*—*Pseudarius jatius*.

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2143/2.

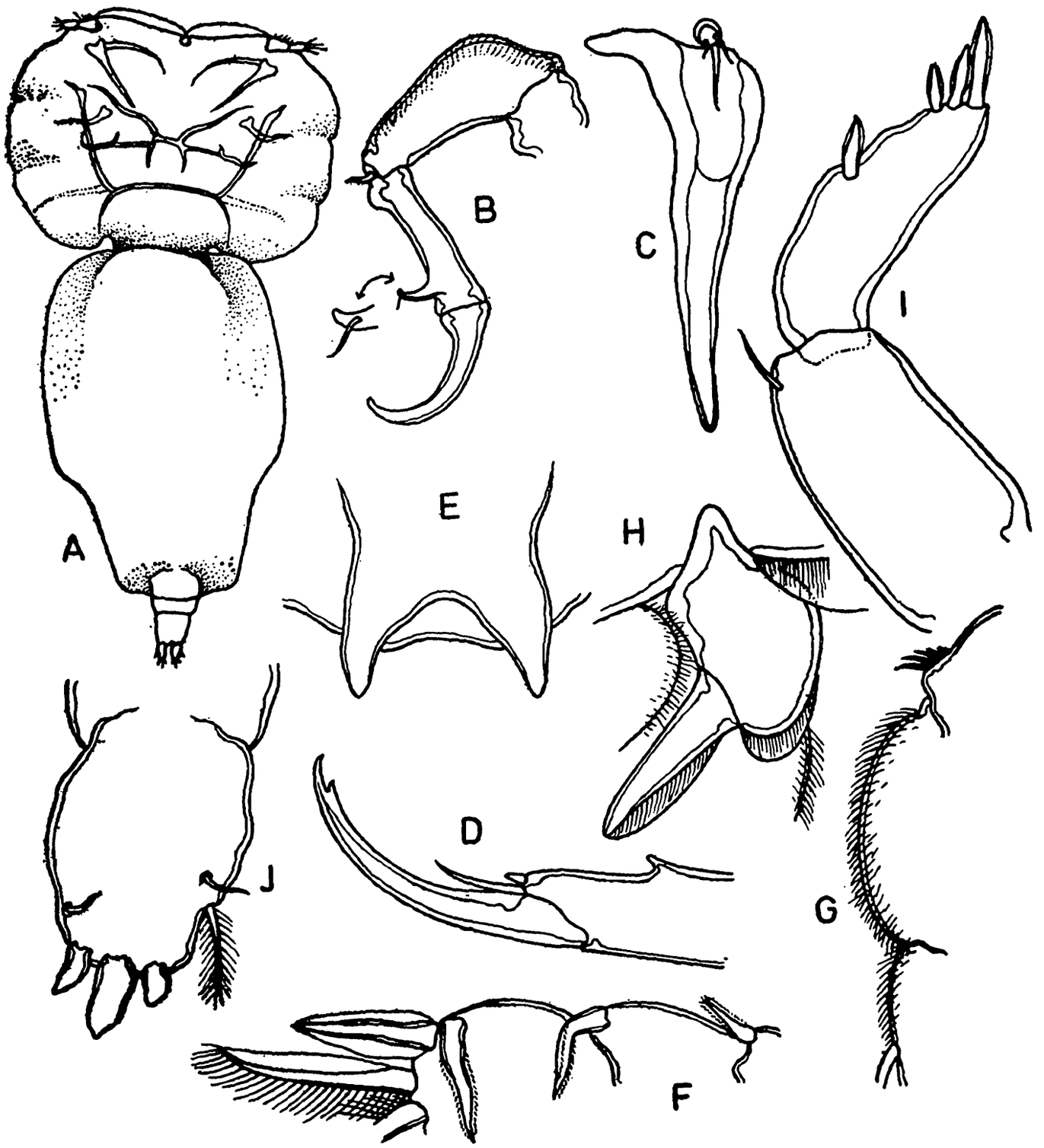


Fig. 144. *Hermilius helleri* Pillai ; A, female, dorsal view ; B, antenna ; C, post-oral process and maxillule ; D, maxilliped ; E, sternal fork ; F, leg 2, exoped ; G, same, endopod ; H, leg 3, basal process of exopod ; I, leg 4 : J. caudal ramus.

*Remarks.—H. helleri* can be distinguished from *H. pyriventris* by the shape of the genital segment, presence of a setule on the

accessory claw of the antenna, presence of two spines on the distal segment of the maxilliped, presence of setules instead of spines on the endopod segments of second leg and by the stouter, almost normal fourth leg.

## **Hermilius tachysuri** Pillai and Natarajan
## (Fig. 145)

*Hermilius tachysuri* Pillai and Natarajan, 1977, p. 38, figs. 103-116.

*Female.*—Cephalothorax comparatively large, frontal plates prominently slanting lnwards. Lateral borders of cephalothorax divided into three lobes, hind part narrower. Fourth thoracic segment clearly visible and comparatively large, equal in length and width. Genital segment much smaller than cephalothorax, its surface transversely rugose. Abdomen short, two-jointed. Caudal rami prominent, with two outer and one inner plumose setae and three distal blunt spines, median spine stout. Egg tubes short.

Antenna comparatively stout, with partition beyond the accessory claw, third segment with proximal inner spinule, both accessory and main claw apically hook-like. Post-antennal process represented by three groups of hairs, post-oral process long, prominently narrowing, apex externally flanged and base internally produced. Maxilla very small, claws very short, wide apart. Maxilliped with short distal segment having an oblique partition demarcating an unguis, unguis with subapical inner tooth and proximal setule, base produced below the unguis as a small tooth. Sternal fork insignificant, considerably deformed, limbs asymmetrical.

Basipod of first leg spiny, with long upper and short lower setae, vestigial endopod very small, rounded and spiny, distal segment of exopod with three long winged claws, first claw as long as the exopod, spine-like seta reduced to a small tooth. First claw of exopod of second leg very small, third curved, modified setae stout, basal endopod segment with a transverse row of spines, second and third with two to three rows of spinules. Apron of third leg externally spiny, claw of exopod slender and long, slightly curved and directed inwards, segmentation of exopod indistinct,

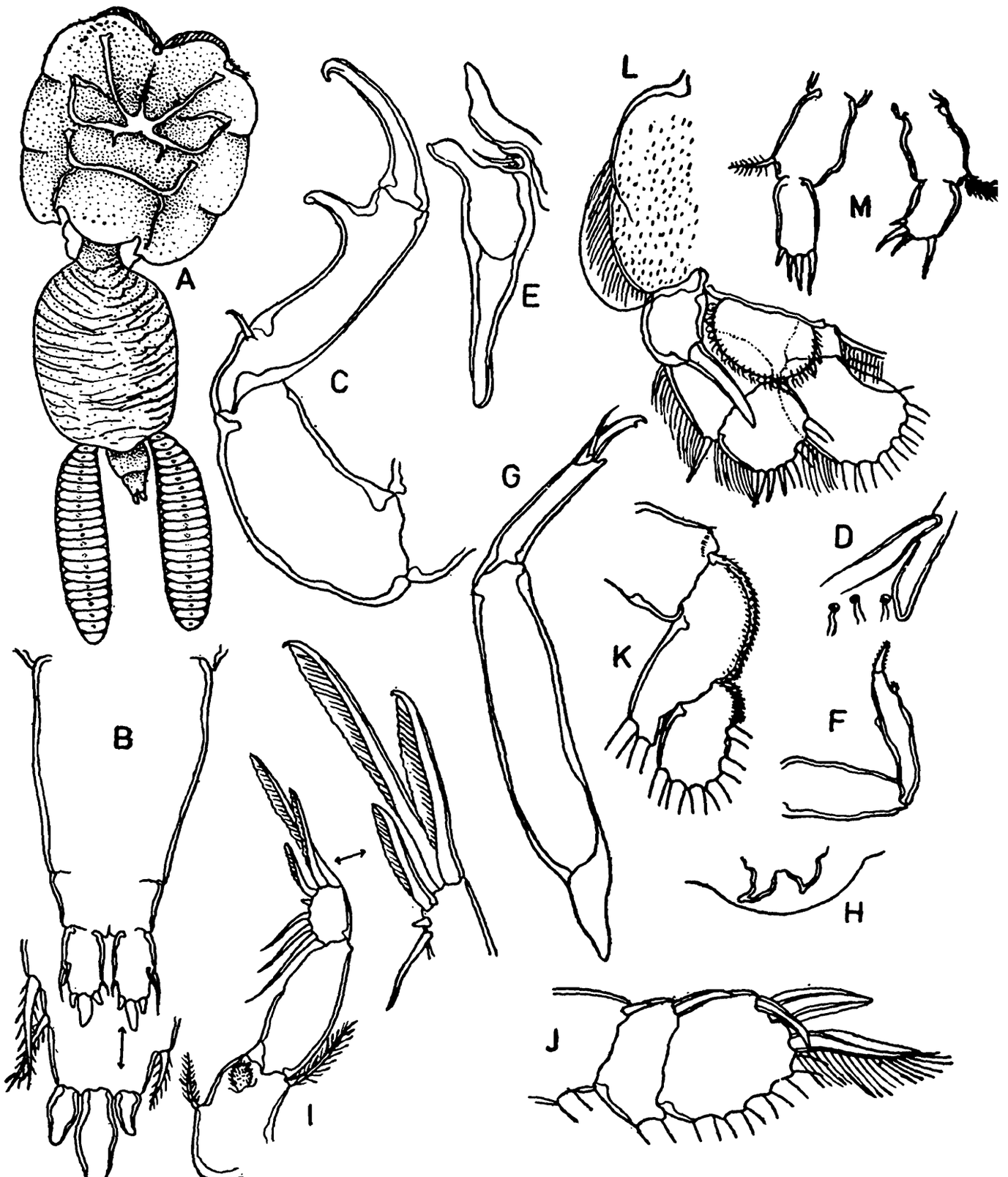


Fig. 145. *Hermilius tachysuri* Pillai and Natarajan : A, female, dorsal view ; B, abdomen and caudal rami ; C, antenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, maxilla ; G, maxilliped ; H, sternal fork ; I, leg 1 ; J, leg 2, exopod ; K, same, endopod ; L, leg 3 ; M, leg 4.

rami overlapping. Fourth leg very small, two-jointed and asymmetrical, first segment larger, with a plumose seta, second with one outer and three distal spines.

*Length.*—3.1 mm.

*Host.*—*Tachysurus* sp.

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2144/2.

*Remarks.*—This species, the smallest known, can be distinguished by the highly degenerated sternal fork and fourth leg, the slender elongated and naked claw of the exopod of the third leg and the very slender post-oral process. In all the other species the post-antennal process is absent but in *H. tachysuri* the three bunches of hairs are present.

## Genus **Tupulina** van Beneden

*Pupulina* van Beneden, 1892, p. 254 ; Wilson, 1935c, p. 593 ; M. S. Wilson. 1952, p. 246 ; Yamaguti, 1963, p. 84 ; Pillai and Padmanabhan, 1963, p. 91.

*Diagnosis.*—Cephalothorax nearly circular, with scattered denticles, postero-lateral lobes with fine marginal hairs. Frontal plates partially fused with cephalothorax, lunules absent. Fourth thoracic segment with a transverse row of denticles. Genital segment fairly large, postero-laterally produced into small conical lobes or large foliaceous processes. Abdomen two-jointed. Caudal rami long, flattened and spinulose.

Antennule and antenna typically caligid. Post antennal and post-oral processes present. Maxilla and maxilliped typically caligid. Sternal fork absent. First leg biramous, endopod small. Segments one and two of endopod of second leg externally expanded. Apron of third leg reduced in size, rami three-jointed, exopod without basal claw, velum large, almost fully covering rami. Fourth leg uniramous, four-jointed, with inner and outer claws, surface spiny.

Male with small genital segment devoid of lobes, abdomen slender. Caudal rami rod-like. Antenna, post-antennal process and maxilliped modified.

Parasites of elasmobranchs (devil rays).

Type species : *P. flores* van Beneden.

*Discussion.*—This genus includes three species, *P. flores* van Beneden (1892), *P. minor* M. S. Wilson (1952) and *P. brevicauda* M. S. Wilson (1952).

From devil rays Brian (1899) described *Diphyllogaster thompsoni*. Brian's illustrations are not adequate for a close comparison but scrutiny of his figures indicates close similarity between his species and *P. brevicauda*. The genital segment is produced into long lobes identical to those of *P. brevicauda* and the abdomen and caudal rami show no difference. The apron of the third leg has an unusually large velum and the fourth leg has inner and outer spines. But brian has clearly stated that the first leg is uniramous. In view of the identity in all other characters one may reasonably suspect that Brian failed to observe the small endopod of the first leg. If so *Diphyllogaster* would become a synonym of *Pupulina*.

Rangnekar (1955b) described a second species of *Diphyllogaster*, *D. aliuncus*, which has no relation to *D. thompsoni*, except that its genital segment is postero-laterally produced. Rangnekar did not respond to my request for specimens. Her species shows close similarity of *Paralebion* Wilson (1911b). It is significant in this context that van Beneden (1892) described an young female of *Paralebion elongatus* as the male of *P. flores*. The status of *Paralebion* itself is questionable.

*Key to species of* **Pupulina**

1. Genital segment postero-laterally produced into two long processes overreaching the caudal rami ..... *brevicauda* M. S. Wilson
— Genital segment postero-laterally produced into short conical processes ..... 2
2. Caudal rami flattened in female, rod-like in male ..... *minor* M. S. Wilson
— Caudal rami rod-like in both sexes ..... *flores* van Beneden

## **Pupulina minor** M. S. Wilson
(Fig. 146-147)

*Pupulina minor* M. S. Wilson, 1952, p. 254, pl. 13 ; Yamaguti, 1963, p. 85, pl. 111, fig. 1 ; Pillai, 1964c, p. 238, figs. 1-19.

*Female.*—Cephalothorax gradually widening backwards, frontal plates almost sunk into the cephalothorax, postero-median lobe projecting. Lateral borders of cephalothorax with a row of fine setae, dorsal surface behind the transverse rib spiny. Fourth segment transversely oblong and spiny. Genital segment short but broad, postero-laterally produced into conical lobes. Abdomen narrow, as long as genital segment, two-jointed and spiny, first segment twice as long as second. Caudal rami laminate, with five highly plumose setae, apex produced into a spine, surface with scattered spinules.

Basal segment of antenna with a small sharp process, distal segment long, apically recurved. Post-antennal process with broad base and short claw, post-oral elongate triangular, claw stout, with an accessory process inner to it. Distal segment of maxilla long and slender, with long outer lobe, claws long, slender and curved. Maxilliped slender.

First leg with two-segmented rami, distal segment of exopod with three long stout setae, a short plumose spine-like seta and three claws, third claw with accessory process. First claw of exopod of second leg large and curved inwards, borders dentate, second shorter, third still smaller, setae not modified, first two segments of endopod expanded into large marginally pectinate lobes making the segments very broad. First segment of exopod of third leg long, with outer distal long barbed spine and a basal conical process carrying a seta, second segment of endopod expanded on both sides, velum large, almost hiding the exopod. Basipod of fourth leg broad, with scattered large spines, second segment with one outer claw, third with outer claw and inner spine, fourth with three apical claws and one spine, both spines plumose.

*Length.*—6.8 mm.

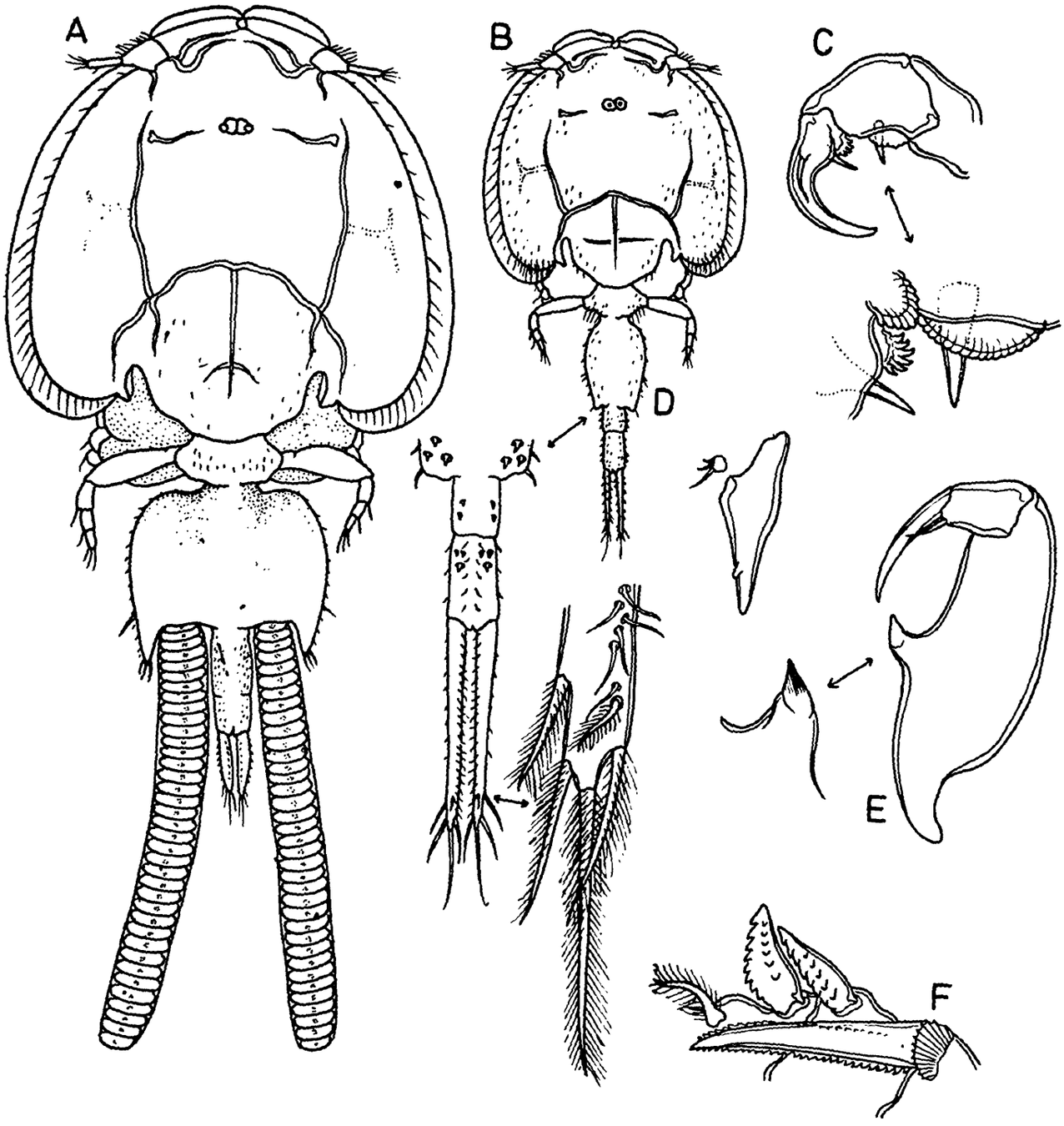


Fig. 146. *Pupulina Minor* M. S. Wilson : A, female, dorsal view. B-F. Male. B, male, dorsal view ; C, autenna ; D, post-oral process and maxillule ; E, maxilliped ; F, leg 2 ; exopod.

*Male.*—Cephalothorax with projecting frontal plates, hairs on postero-lateral lobes longer, median lobe projecting. Fourth segment with transverse row of hairs. Genital segment narrowing,

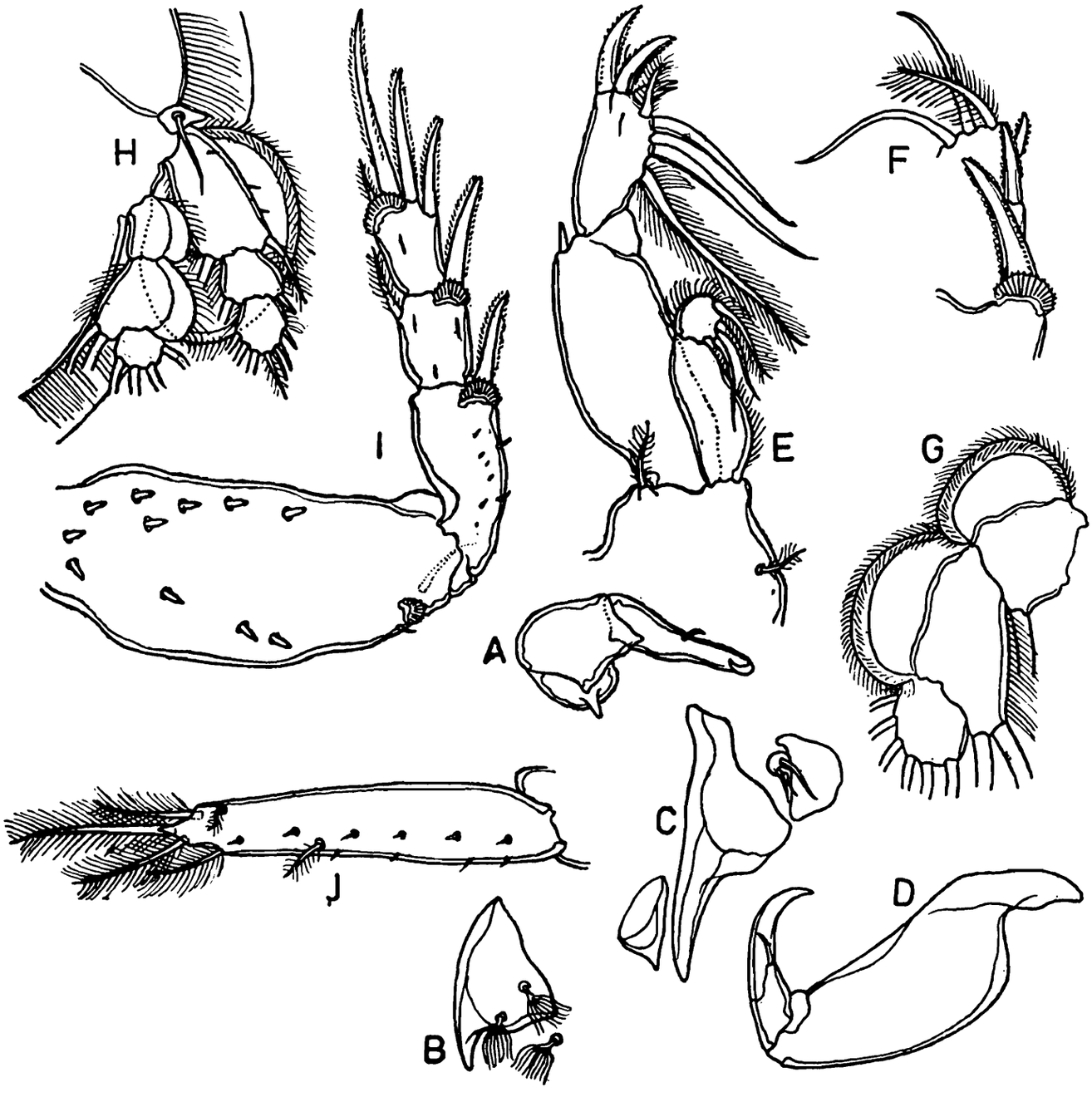


Fig. 147. *Pupulina minor* (contd.) : Female. A, antenna ; B, post-antennal process ; C, post-oral process, accessory process and maxillule; D, maxilliped; E, leg 1 ; F, leg 2, exopod ; G, same, endopod ; H, leg 3 ; I, leg 9.

longer than broad. Abdomen two-segmented. Caudal rami rod-shaped, as long as abdomen, with inner row of plumose setae and four distal plumose setae, apical seta very long. The whole body more spiny than in female.

Second segment of antenna with two serrate bosses and a stout spine-like process, distal segment a long curved claw with an accessory spine and a seta. Post-antennal process with narrow base and long claw, post-oral with small accessory process. Maxilliped stouter, basal segment with median inner process. First claw of exopod of second leg long and dentate, second and third converted into short broad processes with two rows of blunt basally directed teeth.

*Length.*—4.3 mm.

*Host.—Mobula lucasana, M. diabolus.*

*Distribution.*—California, India (Kerala).

*Remarks.—P. minor* shows very close similarity to *P. flores* van Beneden but in the latter the caudal rami are rod-like in the female while they are flattened in *P. minor*. In *P. flores* the chitinous plate in front of the post-oral process is produced into a spine but normal in *P. minor*. In *P. flores* the prolongation of the first endopodal segment of the second leg is larger than that of first, just the reverse in *P. minor*.

## **Pupulina brevicauda** M. S. Wilson

(Fig. 148-149)

*Pupulina brevicauda* M. S. Wilson, 1952, p. 258, pl. 14, figs. 1-7, pl. 15; Yamaguti, 1963, p. 85, pl. 110, fig. 1 ; Pillai and Padmanabhan, 1963, p. 94, figs. 1-3.
? *Diphyllogaster thompsoni* Brian, 1899, p. 7, pl. 3.

*Female.*—Cephalothorax circular, lateral borders with three pairs of constrictions, postero-median lobe only lightly broader than lateral lobes, considerably projecting, posterior sinuses deep. Fourth segment produced at the base of the legs. Genital segment more than half the length of cephalothorax, produced backwards into large lobes reaching well beyond the tip of the caudal rami,

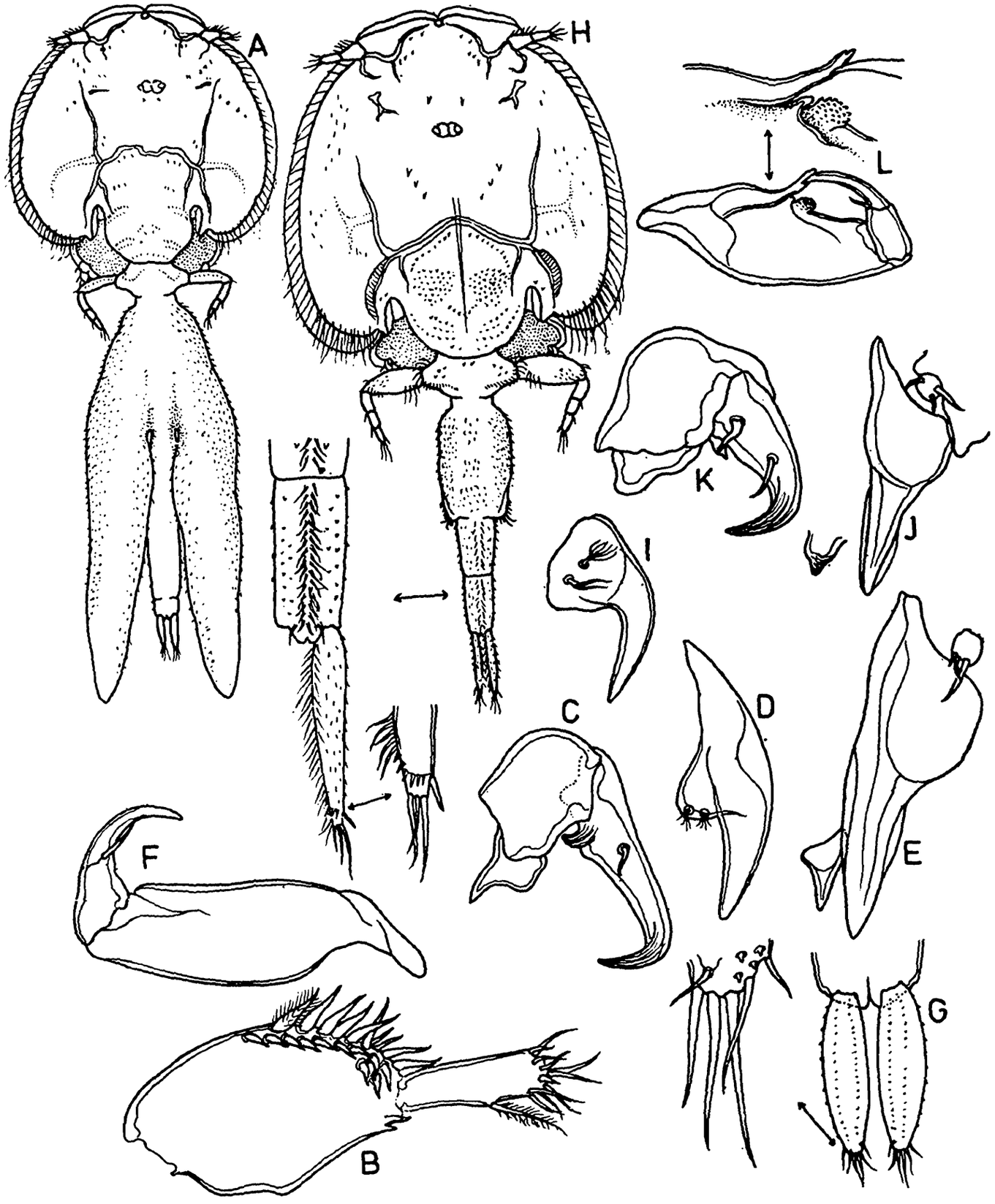


Fig. 148. *Pupulina brevicauda* M. S. Wilson : A-G, Female.A, female, dorsal vew ; B, antennule ; C, antenna ; D, post-antennal process ; E, post-oral process, accessory process and maxillule ; F, maxilliped ; G, caudal rami. H-L, male. H, Male, dorsal view ; I, post-antennal process ; J, post-oral process, accessory process and maxillule ; K, antenna ; L, maxilliped.

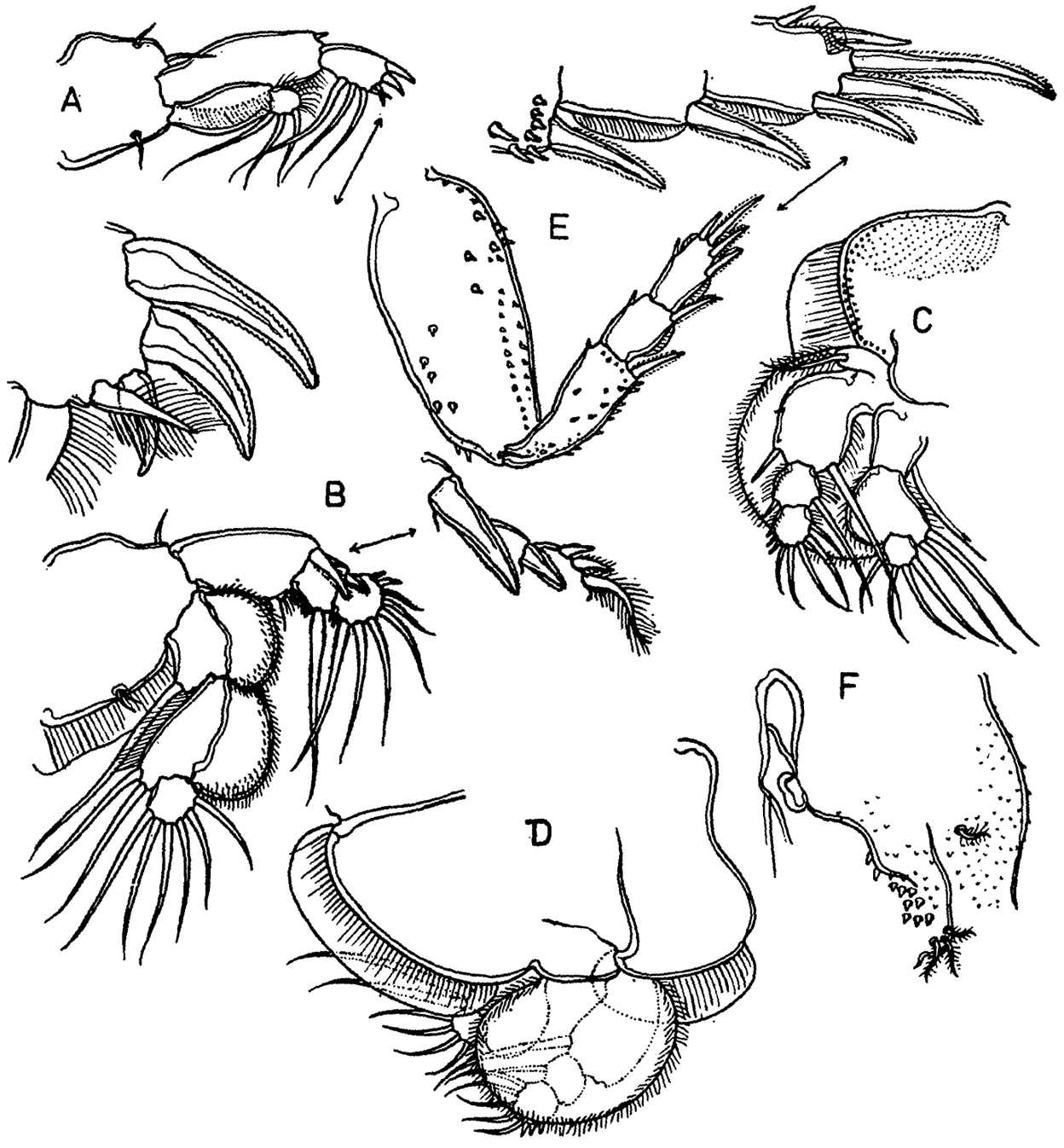


Fig. 149. *Pupulina brevicauda* (contd.) : Female. A, leg 1 ; B, leg 2 ; C, leg 3 ; D, same, outer view ; E, leg 4; F, legs 5-6.

partly overlapping the abdomen. Abdomen only slightly shorter than cephalothorax, slender, parallel sided, two-segmented, second segment very short. Caudal rami laminate, with three long and

three short setae. The entire dorsal surface of body spinulose, spinules concentrated on the lateral parts of genital segment and the genital wings, caudal rami with larger spines.

The seta on the ventral border of the distal segment of antennule plumose. Basal segment of antenna produced into a prominent spine, third segment stout, distally strongly curved. Post-antennal process very broad, with stout claw. Post-oral stout, flanged and with an accessory process inner to it. Outer flange of distal segment of maxilla composed of a discontinuous row of spines, spical claw very long and slender. Maxilliped strong but slender, distal segment with long seta.

First leg as in *P. minor*. First claw of exopod of second leg stout, second small, both winged, third spine-like, endopod segments one and two externally expanded. Outer part of apron of third leg spiny, exopod as in *P. minor* but outer spine on basal segment small and naked, basal seta longer, velum fully covering exopod, rami not overlapping. Fourth leg with very broad basal segment, armature as illustrated.

*Length.*—14.4 mm.

*Male.*—Post-cephalothoracic part of body heavily spiny, dorso-median part of abdomen and inner side of caudal rami setose. Postero-median lobe of cephalothorax evenly rounded. Genital segment roughly rectangular, fourth segment laterally drawn out making the legs project outwards. Abdomen two-jointed, segments subequal. Caudal rami long but not rod-like. Basal segment of maxilliped medially produced into a digitiform process followed by a rounded projection studded with tubercles, basal inner part produced into a long apically bifid process.

*Length.*—7.5 mm.

*Host.—Mobula lucasana, M. giornae, M. diabolus.*

*Distribution.*—Mediterranean, California, India (Kerala).

*Remarks.*—The only character which *Pupulina* shares with the other members of the subfamily is the absence of the lunules. In the nature of practically every appendage this genus is unique. Of particular significance is the biramous nature of the first leg which is very much like that of euryphorids, especially of *Alebion*. *Pupulina* certainly shows some resemblance to *Alebion* but how far this is due to the identity of the hosts is not known.

In all caligids so far dealt with the second and third claws on the distal segment of the first leg, when normally developed, carry an accessory process. In *Pupulina* the second claw lacks a process but that of third is fully fused making the claw truly bifid or forked. In caligids the first exopod segment of the third leg is converted into a claw and this is followed by one or two segments. In *Pupulina* the claw is absent and the exopod is clearly three-jointed. As observed by Kabata the endopod of the third leg in caligids shows only two segments but the first segment is fused with the apron and projects between the rami as the valum. *Pupulina* is different in that the rami are clearly three-jointed and in addition there is an unusually large velum, which apparently is the prolongation of the apron.

Accessory processes in front of the post-oral processes are observed in some caligids. In *Pupulina* this can be included as a generic character. The presence of spines or setae on the outer side of the fourth leg is unique.

## Genus **Lepeophtheirus** Nordmann

*Lepeophtheirus* Wilson, 1905a, p. 615 ; Yamaguti, 1963, p. 71 ; Kabata, 1973a, p. 730.
*Dentigryps* Wilson, 1905a, p. 221 ; Lewis, 1964b, p. 348 ; Hewitt, 1971, p. 329.
*Homoiotes* Wilson, 1913, p. 533 ; Pillai, 1970b, p. 23 ; Kabata, 1973c, p. 1892.
*Indocaligus* Pillai, 1961, p. 125.

*Diagnosis.*—Resembling *Caligus* but without lunules. Post-antennal process simple, post-oral usually bifid. Sternal fork present. Distal claws of first leg generally short but stout. Claws on exopod of second leg subsimilar, first two setae characteristically curved, with broad wings. Fourth leg generally long, four-jointed, claw on first segment very small. Vestigial legs better developed than in *Caligus*.

Male showing pronounced dimorphism in the antenna, post-antennal process, post-oral process and the fifth and sixth legs. Antenna swollen, with accessory process and large adhesion pads. Post-oral process usually trifid. Genital segment produced into conical lobes carrying the fifth and sixth legs.

Mainly parasitic on teleosts, rarely on elasmobranchs.

Type species : *L. pectoralis* Nordmann.

*Discussion.*—As observed by Kabata (1973c) this genus includes a very large number of species which are often difficult to identify. They can, however, be divided into two groups, one with long abdomen and the other with short or very short abdomen. The latter has much taxonomic significance.

After examining *Homoiotes palliata* in the British Museum Pillai (1970b) suggested that it should be transferred to *Lepeophtheirus*. Since then Kabata (1973c) studied the types in the Smithsonian Institution and found that it is a mixture of *L. parvipes* Wilson (1912b), *L. breviventris* Fraser (1920) and *L. bifidus* Fraser (1920). *Homoiotes* is hence a synonym of *Lepeophtheirus*.

While redescribing *Lepeophtheirus spinifer* Kirtisinghe Pillai (1963f) observed that *Dentigryps* should be made a synonym of *Lepeophtheirus*. This view has since been supported by Hewitt (1971) who treated it as a synonym. Dentigryps and *Homoiotes* belong to the group of *Lepeophtheirus* with short abdomen. This group shows much affinity to the genera included in Anur tinae.

*Lepeophtheirus* is the second largest caligid genus. This genus is comparatively poorly represented in the Indo-West Pacific. From the Indian waters less than a dozen species have been recorded. Kabata (1970a) observed that this genus prefers colder waters.

*Key to species of* **Lepeophtheirus**

1. Genital segment larger than cephalothorax . *latigenitalis* Pillai and Natarajan
— Genital segment smaller than cephalothorax .2

| | | |
|---|---|---|
| 2. | Sternal fork absent | .*aesopus* Wilson |
| — | Sternal fork present | .3 |
| 3. | Fifth leg a chitinised process reaching beyond the genital segment | .4 |
| — | Fifth leg not chitinised, not reaching beyond the genital segment | .6 |
| 4. | Fifth leg short, stopping short of the tip of the abdomen | .*goniistii* Yamaguti |
| — | Fifth leg long, overreaching abdomen | .5 |
| 5. | Base of claw of exopod of third leg enlarged, post-antennal process with accessory process | .*cresseyi* (Cressey) |
| — | Basal claw of exopod of third leg not enlarged, post-antennal process without accessory lobe | .*spinifer* Kirtisinghe |
| 6. | Fourth leg two-jointed | .*brachyurus* Heller |
| — | Fourth leg four-jointed | 7 |
| 7. | Genital segment postero-laterally produced into large lobes reaching beyond abdomen | .*crassus* (Wilson and Bere) |
| — | Genital segment not produced into large lobes | .8 |
| 8. | Claws on fourth leg subsimilar, with broad crenate wings | .*longipalpus* Bassett-Smith |
| — | Claws on fourth leg dissimilar, with normal wings | .9 |
| 9. | Genital segment circular, with a pair of submedian dorsal spines | .*rotundiventris* Bassett-Smith |
| — | Genital segment broadening backwards, without dorsal spines | .*lagocephali* Pilla |

## **Lepeophtheirus brachyurus** Heller

*Lepeophtheirus brachyurus* Heller, 1868, p. 185, pl. 16, fig. 4 ; Wilson, 1906, p. 190, pl. 1, figs. 1-10 ; Barnard, 1955, p. 253 ; fig. 12 ; Yamaguti, 1963, p. 72, pl. 96, fig. 1.

*Female.*—Cephalothorax regularly broadening backwards, frontal plates very low, postero-median lobe about three to four times as broad as lateral lobes, medially concave and slightly overlapping fourth segment. Latter more or less fused with genital segment. Genital segment swollen, much narrower than cephalothorax, broader than long. Abdomen very short, one-segmented and attached to the ventral side of genital segment. Caudal rami slightly immersed in the abdomen, as long as broad, with long setae. Egg tubes longer than body.

Distal segment of antennule very short. Basal segment of antenna without process, distal segment apically recurved. Post-antennal process very small, with enlarged base. Post-oral process as broad-based strongly curved claw. Maxilliped stout, basal segment with an inner distal prominent process hollowed on the inner side, distal segment a strong well curved claw carrying a long basal spine. Sternal fork with stout base and short, narrowing and slightly diverging apically blunt rami.

Basipod of first leg subequal to first segment of exopod in size, distal exopod segment with subsimilar claws, spine-like seta slightly longer than the third claw, ventral setae large. Claws on exopod of second leg comparatively small endopod segments externally hairy. Exopod of third leg three-jointed, basal segment apparently not converted into a claw ? but an outer small spine present, endopod one-jointed, rami placed apart and intervened by a conical velum. Fourth leg very characteristic, small and two-jointed, joints subequal in length, distal with two short, similar claws.

*Length.*—4.5 mm.

*Host.—Tetrodon calamariae, T stellatus, T hypselogeneion Scorpaena guttata.*

*Distribution.*—Java, Sri Lanka, Durban, California.

*Remarks.*—I have no specimen of this species and this description is after Wilson. Wilson's description particularly of the third and fourth legs is rather misleading. According to the text the second segment of leg four carries three spines but the figure shows only two. His figure of the third leg shows a small spine instead of the usual claw. This is doubtful. If the fourth leg is small and two-jointed that alone would suffice to identify this species.

Barnard has described a specimen with projecting postero-median lobe of cephalothorax, genital segment with angular postero-lateral parts and much reduced abdomen. Its fourth leg was missing.

## **Lepeophtheirus aesopus** Wilson

*Lepeophtheirus aesopus* Wilson, 1906, p. 192, pl. 1, figs. 11-19 ; Yamaguti, 1963, p. 72.

*Female.*—Cephalothorax nearly as long as broad, gradually widening backwards, postero-median lobe less than twice as broad as lateral lobes and clearly projecting beyond the latter. Frontal plates rather broad and projecting. Fourth segment large, transversely oblong. Genital segment roughly squarish, with short anterior neck, postero-medially produced over the abdomen. Abdomen two-segmented, but basal segment with an incomplete partition. Caudal rami much longer than broad, with short setae. Egg tubes slightly shorter than body.

Distal segment of antenna strongly narrowing distalwards, apically strongly curved. Post-antennal process as very small curved claw. Post-oral process elongate triangular. Maxilliped rather small, basal segment roughly cylindrical, distal segment a slender claw. Sternal fork absent.

Spine-like seta on distal segment of first leg slightly longer than the third claw, ventral setae long. Endopod segments of second leg illustrated as unarmed. Third leg with two-jointed endopod and three-jointed exopod, rami placed close together and overlapped by the velum. Instead of the basal claw the first exopod segment is shown with a small spine, the ramus according to Wilson is very long. Basal segment of fourth leg broad, second and third segments with one and fourth with three spines, apical spine one and a half times as long as the subapical, second joint having an oblique rather than a transverse septum and the spine, contrary to the typical condition, normally developed.

*Length.*—5.75 mm.

*Host.*—Unknown.

*Distribution.*—Sri Lanka.

*Remarks.*—This species has never been redescribed. As the name implies the legs are quite different from those of its congeners but

Wilson's description might not be entirely correct. The absence of the sternal fork, if true, will be a unique character.

### **Lepeophtheirus rotundiventris** Bassett-Smith

*Lepeophtheirus rotundiventris* Bassett-Smith, 1898b, p. 85, pl. 5, fig. 1 ; Yamaguti, 1963, p. 77.

*Female.*—Cephalothorax nearly rounded, postero-median lobe as broad as lateral lobes. Frontal plates projecting. Fourth segment rather elongated. Genital segment perfectly circular, with a pair of submedian dorsal spines. Abdomen short, one-jointed, proximally constricted, swollen in the middle and narrowed distally.

Post-antennal process with swollen base, claw short and curved. Post-oral process bifid. Maxilla and maxilliped of the usual type. Sternal fork with short, slightly diverging branches.

Spine-like seta on distal segment of first leg long. Legs two to four of the usual type but the description lacks details. Fifth leg a projecting nodule on genital segment carrying three setae.

*Length.*—4.5 mm.

*Host.—Epinephelus alexandrinus, E. gigas.*

*Distribution.*—Sri Lanka, Muscat, Mediterranean.

*Remarks.*—The original description based on a single female gives no details. The nearly circular genital segment with pair of dorsal spines serves to identify this species but Bassett-Smith makes no mention of the spines in his description. According to him this species resembles *L. brachyurus* Heller but differs in many details. The fourth leg in Heller's species is two-jointed whereas it is normal and four-jointed in *L. rotundiventris.* Brian has described this species but I could not consult his publication.

### **Lepeophtheirus spinifer** Kirtisinghe
(Fig. 150)

*Lepeophtheirus spinifer* Kirtisinghe, 1937a, p. 441, figs. 41-58 ; Rangnekar, 1959, p. 51, fig. 4 ; Pillai, 1961, p. 128, fig. 23 ; 1966, p. 133, fig. 7 ; Yamaguti, 1963, p. 77 ; Lewis, 1964b, p. 378.

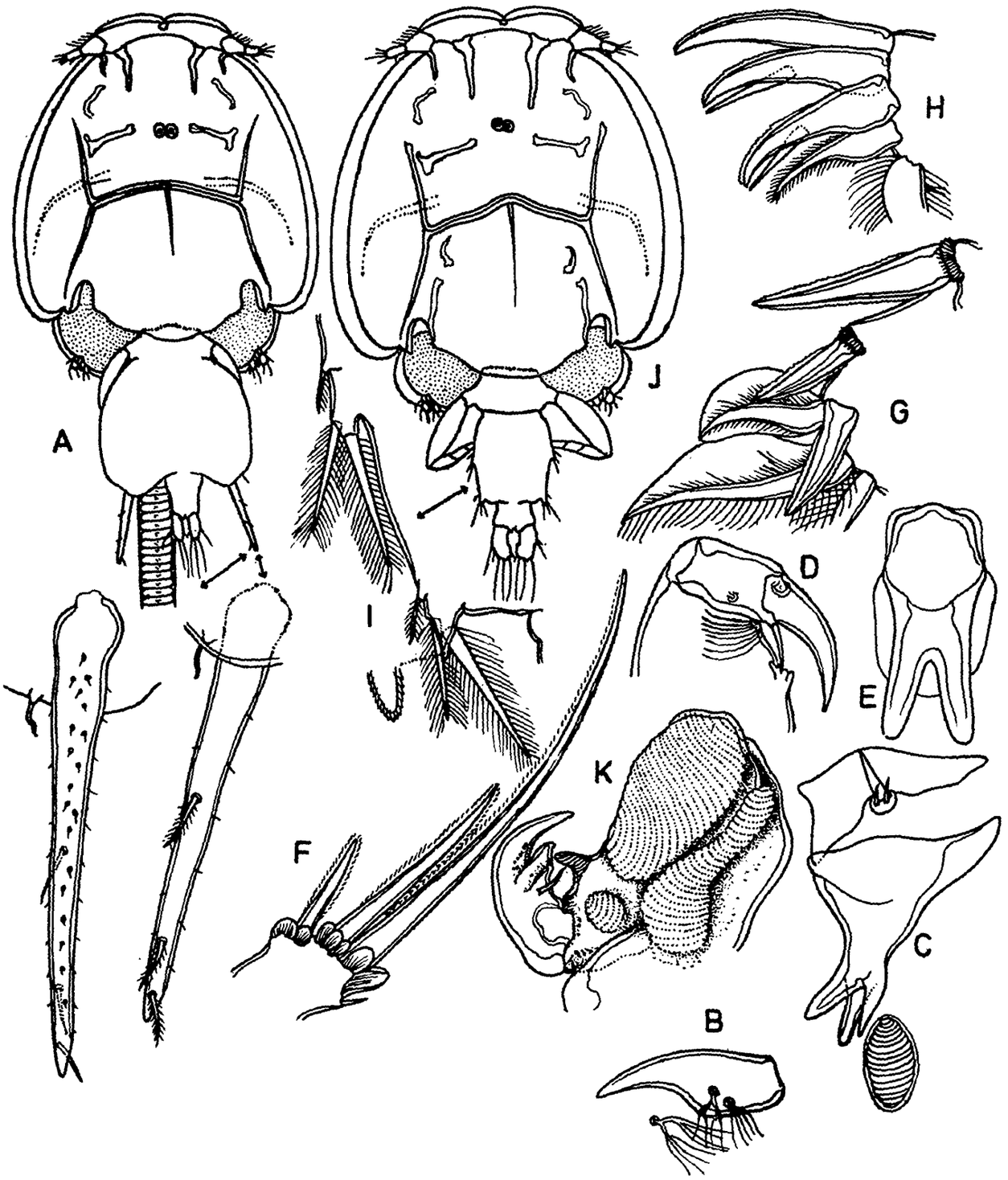


Fig. 150. *Lepeophtheirus spinifer* Kirtisinghe : A, B & D-G, Female. A, female, dorsal view ; B, post-antennal process ; D, maxilliped ; E, sternal fork ; F, leg 4 ; G, leg 2, exopod ; H, leg 11 ; C & I-K, Male. C, post-oral process and maxillule of male ; I, legs 5-6 ; J, male, dorsal view ; K, antenna.

*Female.*—Cephalothorax broadening backwards, frontal plates low, inclined backwards, postero-median lobe more than twice as broad as lateral lobes, posterior sinuses fully open. Fourth segment much broader than long, genital segment swollen, broader than long, postero-laterally produced into large lobes. Abdomen long, one-jointed, basal half swollen. Caudal rami much longer than broad.

Basal segment of antennule nearly equal in length and width. Antenna somewhat irregular, basal segment proximally produced. Post-antennal process with stout base and short claw, post-oral triangular, strongly curved. Distal segment of maxilla slender, claws short. Basal segment of maxilliped with distal trifid process. Sternal fork with short, apically rounded diverging rami.

Claws on distal segment of first leg stout, with narrow dorsal wing, second and third with accessory process, spine-like seta short but stout and plumose, ventral setae normal. First claw of exopod of second leg stout and winged, endopod segments hairy. Apron of third leg with outer adhesion pad, rami small, overlapping, basal claw of exopod with large bulging base. Fourth leg four-segmented, second segment without claw, fourth with three winged nearly straight claws, the crest of spines at their base forming rounded lobes, up to three near each claw. Fifth leg a long chitinised process overreaching the caudal rami and carrying three dorsal plumose setae, surface with scattered spinules.

*Length.*—5.6 mm.

*Male.*—Cephalothorax large, frontal plates projecting, postero-median lobe about four times as broad as lateral lobes, distally rounded. Fourth segment broader than genital segment, latter medially constricted to accommodate the fifth legs and distally produced to carry the sixth legs. Abdomen short, one-segmented.

Basal segment of antenna with a large adhesion pad, second with one large and two small pads, one of the smaller pads digitiform, distal segment short, stout and trifid, distal process claw-like. Claw of post-antennal process longer, post-oral process large, with

two accessory processes, one sharp, the other blunt, there is an adhesion pad inner to the process.

*Length.*—2.3 mm.

*Host.—Chorinemus lysan, C. tala, Rachycentron canadus.*

*Distribution.*—Sri Lanka, India (Bombay, Kerala).

*Remarks.*—In my earlier description of this species the sternal fork was illustrated as apically acute and diverging. It is apically blunt as illustrated by Rangnekar and not deverging.

## **Lepeophtheirus longipalpus** Bassett-Smith
(Fig. 151)

*Lepeophtheirus longipalpus* Bassett-Smith, 1898b. p. 86, pl. 5, fig. 2 ; Pillai, 1963f, p. 92; Yamaguti, 1963, p. 74 ; Kirtisinghe, 1964, p. 80.
*Indocaligus echinus* Pillai, 1961, p. 127, fig. 22.

*Female.*—Cephalothorax rounded, frontal plates low, postero-median lobe rectangular, not projecting, posterior sinuses fully open. Fourth thoracic segment slightly broader than long, genital segment pyriform, broadening backwards, one and a half times as long as broad. Abdomen long and slender, two-jointed, second segment very short. Caudal rami small.

Basal segment of antennule with straight pectinate setae. Basal segment of antenna with apically rounded large process, distal segment strong. Post-antennal process absent, Post-oral process slender, curved and apically acute, claws of maxilla straight, winged and greatly unequal. Maxilliped slender, distal segment well curved. Sternal fork with short base and long apically rounded slightly diverging rami.

Dorsal seta on basipod of first leg stout and pectinate, vestigial endopod oblong, with spiny surface. Lower part of basal segment of exopod hirsute, distal segment with three long stout setae, spine-like seta small, claws with broad lower wing, second and third with accessory process. First claw of exopod of second leg

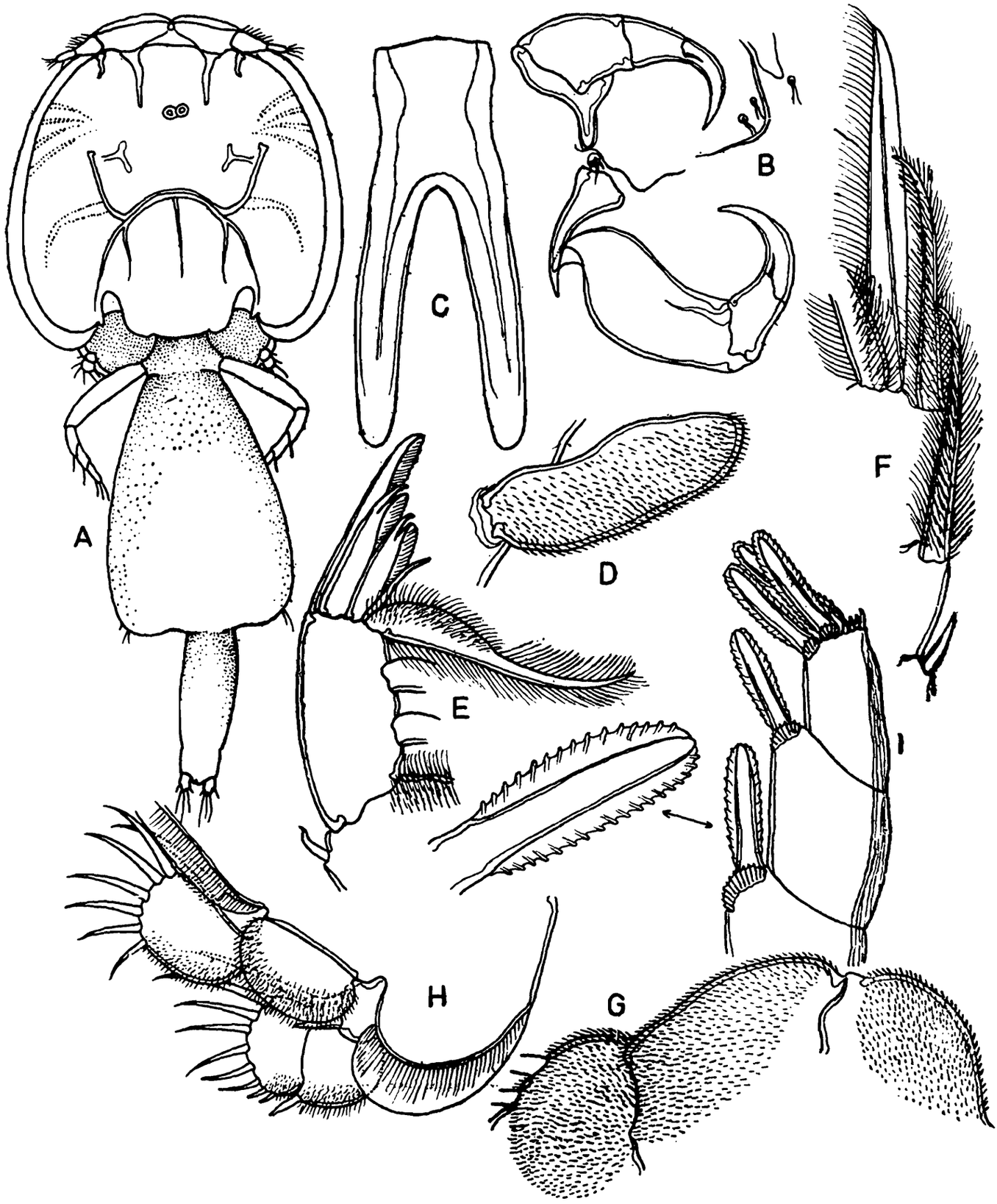


Fig. 151. *Lepeophtheirus longipalpus* Bassett-Smith : A, female, dorsal view ; B, antenna, post-antennal process, post-oral process and maxilliped ; C, sternal fork ; D, leg 1, vestigial endopod ; E, same, exopod ; F, leg 2, exopod ; G. same, endopod ; H, leg 3 ; I, leg. 4.

very small and naked, second and third long, hirsute all over, first seta winged and unlike as usual straight, endopod segments with broad patches of spinules. Apron of third leg reduced in size, rami and velum conspicuously pectinate, basal claw of exopod very small. Fourth leg four-segmented, basal segment long, claws five in all, subsimilar, with characteristically serrate broad wings.

*Length.*—5.6 mm.

*Host.—Arius acutirostris, Pseudarius jatius, Ariodes dussumieri.*

*Distribution.*—India (Kerala), Sri Lanka.

*Remarks.—L. longipalpus* is unique in many respects. It usually occurs along with *Caligus arii* from which it can be distinguished only by the absence of lunules. These two species show such identity of characters as to provide a unique example of adaptive convergence.

### **Lepeophtheirus lagocephali** Pillai
(Fig. 152)

*Lepeophtheirus lagocephali* Pillai, 1963f, p. 93, fig. 16; 1967d, p. 1607, fig. 111.

*Female.*—Cephalothorax very large, as long as broad, frontal plates unusually small, postero-median lobe convex, about twice as broad as lateral lobes. Fourth segment small, broader than long. Genital segment swollen, as long as broad, postero-laterally rounded. Abdomen very short, apparently two-segmented.

Basal segment of antenna without process, distal stout, strongly curved. Post-antennal process with broad base and narrow slightly curved blunt claw, post-oral with swollen base and asymmetrically bifid claw. Sternal fork with squarish base, limbs longer than base, narrowing and diverging.

Claws on distal segment of first leg short, stout and winged, spine-like seta pectinate, slightly longer than third claw, ventral setae stout, vestigial endopod indistinctly three-jointed, carrying a spinule. Endopod segments of second leg hairy. Rami of third

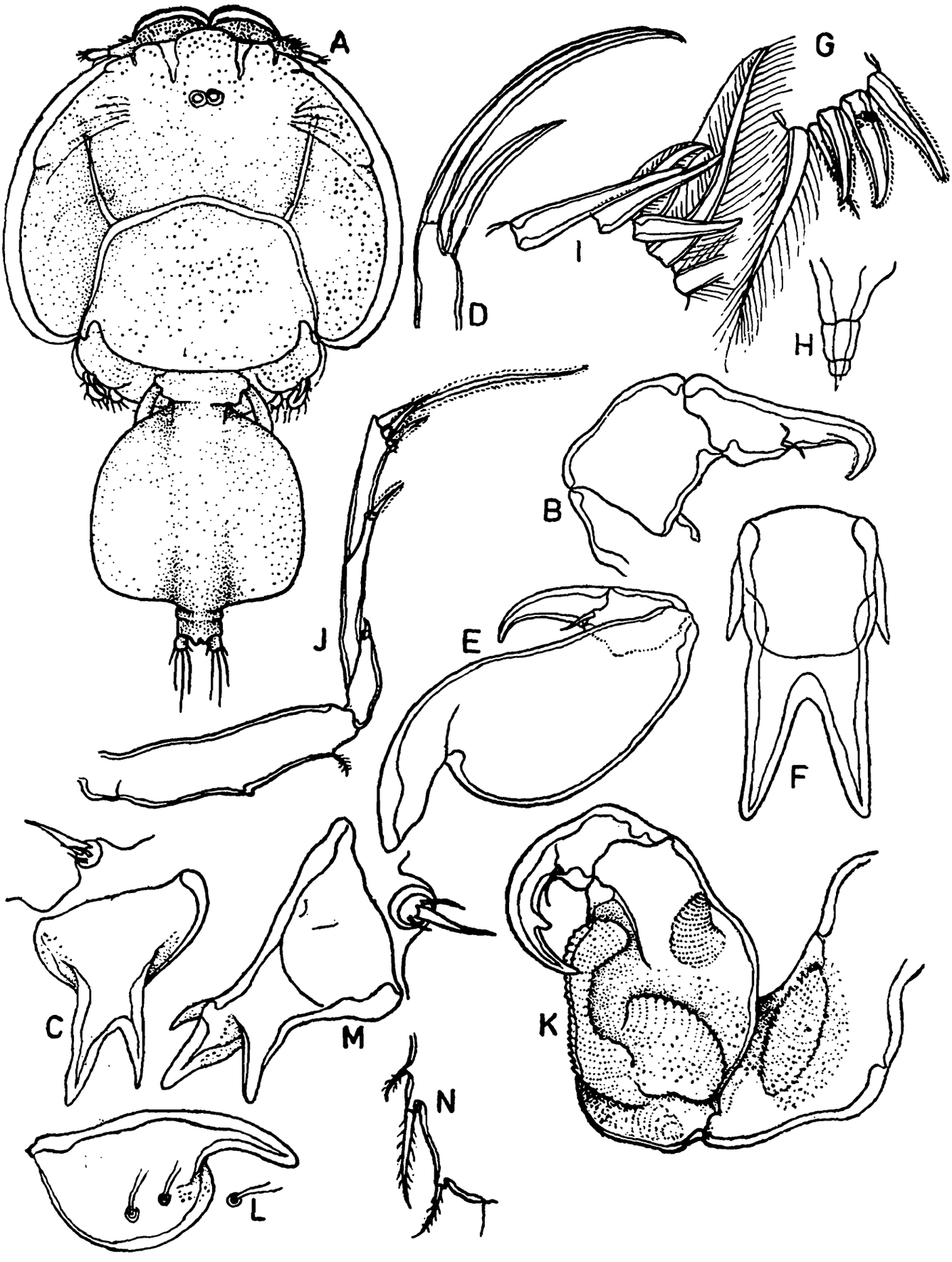


Fig. 152. *Lepeophtheirus lcgocephali* Pillai : A, female, dorsal view ; B, antenna; C, maxillule and post-oral process ; D, maxilla ; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, same, vestigial endopod; I, leg 2, exopod ; J, leg 4. K-N, Male. K, antenna ; L, post-antennal process; M, post-oral process and maxillule ; N, legs 5-6.

leg placed close together. Fourth leg four-segmented, second segment with very small claw, last claw very long, more than three times as long as the penultimate.

*Length.*—4.4 mm.

*Male.*—Postero-median lobe of cephalothorax medially concave and overlapping fourth segment. Genital segment very small, with lateral indentations carrying fifth and sixth legs. Abdomen very short and one-segmented.

Basal segment of antenna with one dorsal adhesion pad, second segment very stout, with two dorsal and two ventral pads, third segment strongly curved, with basal seta and distal lower small accessory process. Post-antennal process as in female, post-oral with small accessory process.

*Length.*—3.5 mm.

*Host.—Lagocephalus inermis.*

*Distribution.*—India (Kerala).

*Types* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2145/2 & C 2146/2.

## **Lepeophtheirus crassus** (Wilson and Bere)
(Fig. 153)

*Gloiopotes crassus* Wilson and Bere, 1936, p. 590, pl. 5, figs. 109-111; pl. 6, figs. 125-135.

*Lepeophtheirus crassus* Shiino, 1960d, p. 546, figs. 3-4 ; Yamaguti, 1963, p. 72 ; Lewis, 1967, p. 76, figs. 28-30.

*Female.*—Cephalothorax slightly longer than broad, elegantly rounded, frontal plates not projecting. Postero-median lobe three to four times as broad as lateral lobes, posterior sinuses prominent. Fourth thoracic segment short but broad, produced into prominent lobes at the base of the legs. Genital segment broader than long but postero-laterally produced into large apically rounded lobes making the segment appear longer than broad. Abdomen two

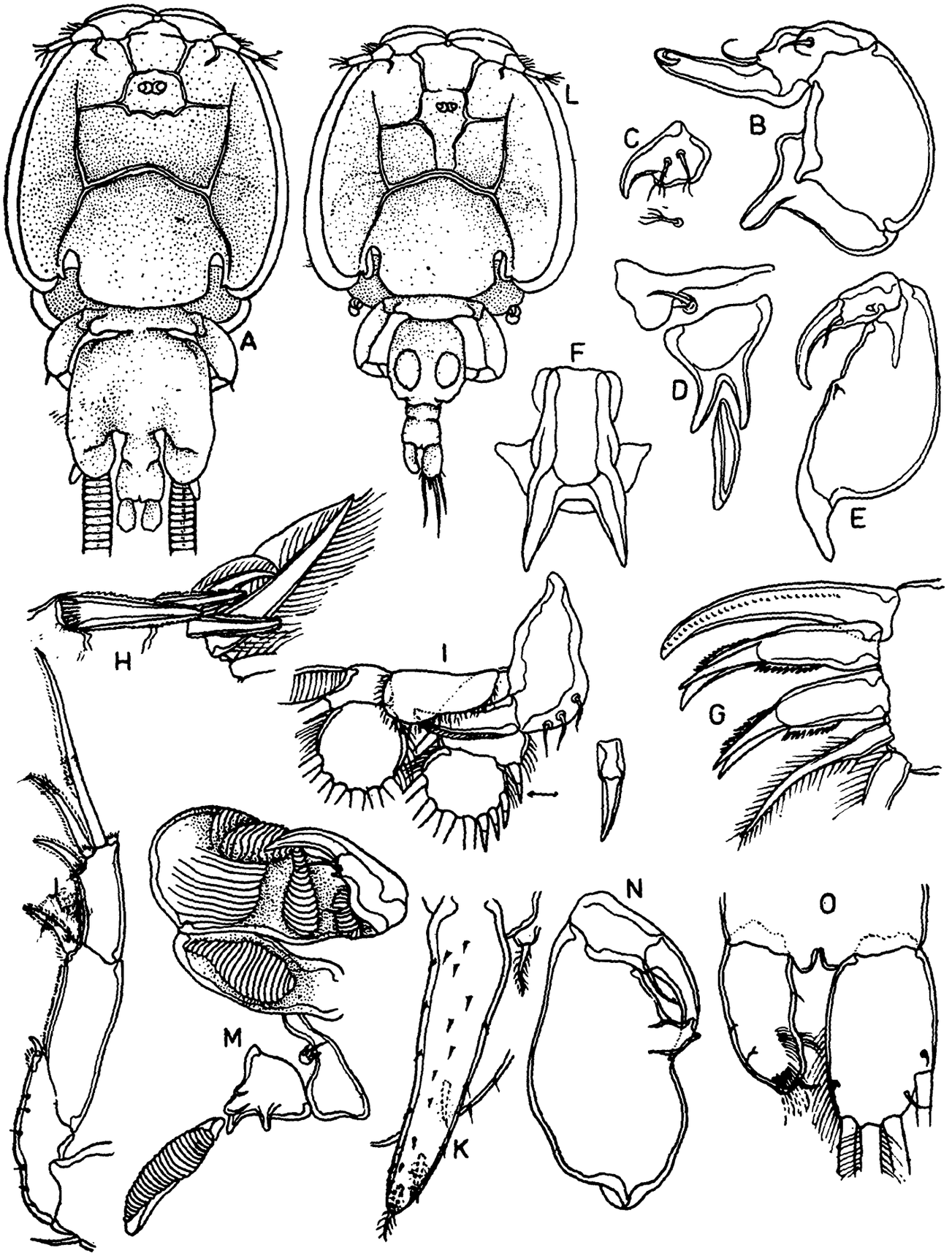


Fig. 153. *Lepeophtheirus crassus* (Wilson and Bere) : A-K, Female. A, female dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, maxilliped ; F, sternal fork ; G, leg 1 ; H, leg 2, exopod ; I, leg 3 ; J, leg 4 ; K, leg 5. L-O, Male. L, male, dorsal view ; M, antenna, post-antennal process and maxillule ; N, maxilliped ; O, caudal rami.

segmented, first segment comparatively narrow, second enlarged. Caudal rami flattened.

Basal segment of antenna produced into a prominent apically blunt process, second segment large, third with broad base carrying two setae, apex recurved. Post-antennal process small, base large, claw short and curved. Post-oral process with accessory process subequal to the main claw in size, with an adhesion pad placed partially between the processes. Basal segment of maxilliped with inner median projection carrying a blunt spine, second segment well curved, with a blunt process and a spine. Base of sternal fork as long as limbs, latter narrowing and slightly diverging.

Claws on distal segment of first leg stout, successively decreasing in length, second and third barbed and with large accessory process, spine-like seta slightly longer than third claw, plumose. Claws on exopod of second leg straight, with narrow irregularly dentate flange, first two setae winged on upper side. Basal claw of exopod of third leg with stout base carrying three setae, claw slightly curved, with narrow outer flange, spines on outer border of exopod jointed. Fourth leg four-jointed, second joint with about five inner spinules and a short claw, apical claw twice as long as the subapical. Fifth leg a chitinised process overreaching the lobes of the genital segment and armed with three plumose setae and several spinules. Sixth leg a nodule carrying a plumose seta.

*Length.*—6.0 mm.

*Male.*—Cephalothorax and fourth thoracic segment as in the female. Genital segment narrower than fourth segment, very slightly longer than broad. Abdomen two-jointed. One of the caudal rami deformed, probably a regenerate. Basal segment of antenna with one and second with four adhesion pads as shown in figure, third segment with a tooth and two spines. Post-oral process smaller than in female, with a conical accessory process and two blunt additional lobes, adhesion pad shifted backwards and corrugated. Basal segment of maxilliped with one small and one large process.

*Length.*—4.5 mm.

*Host.—Rhombochirus osteochir, Remilegia australia, Echeneis albescens.*

*Distribution.*—Western Atlantic, Eastern Pacific and Indian Ocean (Bay of Bengal).

*Remarks.*—Wilson and Bere originally described this species under *Gloiopotes*. In defence of their action it must be stated that the fourth segment has large lobes which are however quite different from the dorsal plates of *Gloiopotes*. The fourth segment and the lobed genital segment distinguish this species.

### **Lepeophtheirus goniistii** Yamaguti

*Lepeophtheirus goniistii* Yamaguti, 1936b, p. 10, pl. 9, figs. 132-133 ; Shiino, 1952, p. 95, figs. 7-9 ; 1959c, p. 343, fig. 5 ; Kirtisinghe, 1964, p. 78, fig. 91.

*Female.*—Cephalothorax large, equal in length and width, frontal plates projecting, median lobe about three times as broad as lateral lobes and projecting. Fourth segment short, drawn out laterally holding the fourth legs away from the genital segment. Genital segment small, broader than long, its hind border with a pair of small triangular projections. Adbomen short, one-segmented, nearly as long as broad.

Antennule short but stout. Basal segment of antenna with blunt process. Post-antennal process small. Post-oral process bifurcated. Sternal fork with diverging limbs.

Legs one and two of the usual type. Basal claw of exopod of third leg small and incurved, its base produced into a rounded lobe extending far beyond the base of the claw. Fourth leg normal. Fifth leg a conical chitinised process carrying four setae.

*Length.*—4.0 mm.

*Male.*—Fourth thoracic segment less produced but the legs held apart because of the small size of the genital segment. Genital segment with two postero-lateral triangular projections carrying the fifth and sixth legs. Antenna modified, with adhesion pads,

third segment bifid, with a third process between them and below their base. Post-antennal process larger. Basal segment of maxilliped with two inner tubercles. Basal claw of exopod of third leg normal.

*Length.*—2.8 mm.

*Host.*—*Goniistius zonatus*, *Promicrops lanceolatus*, *Callyodon ovifrons.*

*Distribution.*—Japan, Sri Lanka.

**Lepeophtheirus latigenitalis** Pillai and Natarajan
(Fig. 154)

*Lepeophtheirus latigenitalis* Pillai and Natarajan, 1977, p. 36, figs. 92-102.

*Female.*—Cephalothorax remotely triangular, anteromedially angular, postero-lateral lobes large and rounded, as broad as median lobe, latter projecting beyond the former. Frontal plates projecting, membranous flange very narrow. Fourth segment fused with genital segment, overlapped by the median lobe of cephalothorax. Genital segment very large, with anterior neck, postero-laterally rounded and postero-medially slightly produced. Abdomen reduced, originating from the ventral side of the genital segment. Caudal rami small, attached to ventral side of abdomen. Egg tubes short but stout.

Basal segment of antennule sparsely setose. Basal segment of antenna with large process, third segment slender. Post-antennal process with small lobe and irregular apically blunt claw with a dorsal hump. Post-oral process triangular, with very broad base and short claw. Maxillule with very small setae. Distal segment of maxilla longer than basal, claws placed wide apart. Basal segment of maxilliped stout, distal segment strongly curved. Sternal fork with triangular base, limbs short, flat, apically rounded and parallel.

First leg short, but stout distal segment with three stout barbed claws, a slender smooth spine-like seta and three ventral setae, latter decreasing in length basalwards. First claw of exopod of

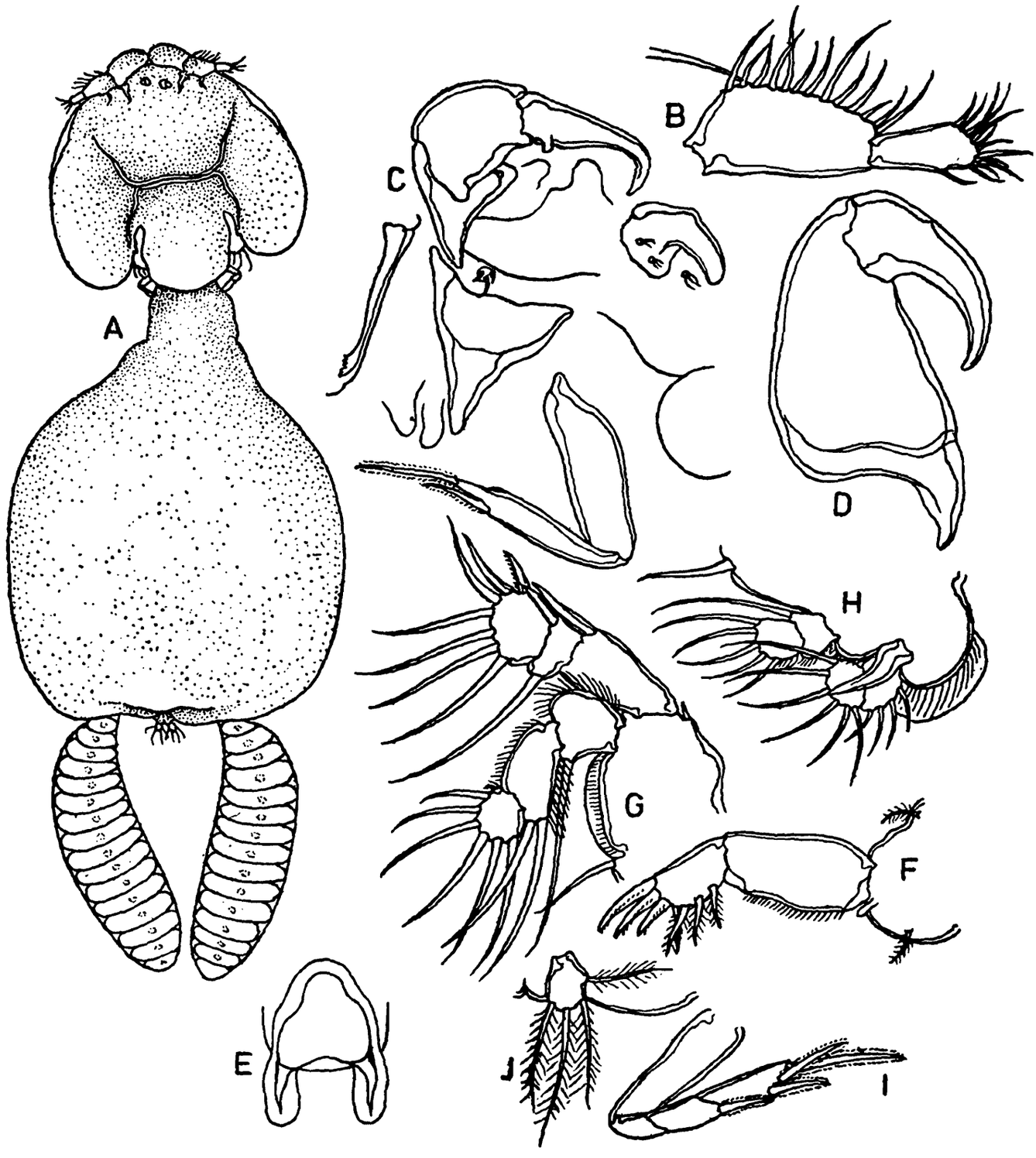


Fig. 154. *Lepeophtheirus laitgenitalis* Pillai and Natarajan : A, female, dorsal view ; B, antennule ; C, antenna, post-antennal process, post-oral process and maxillule and maxilla ; D, maxilliped ; E, sternal fork ; F-I, legs 1-4 ; J, caudal ramus.

second leg large, second small, third long and setiform, first seta curved as usual. Outer border of endopod segments spinulose.

Apron of third leg reduced in size, rami placed apart, basal claw of exopod large. Fourth leg four-jointed, third segment with one and fourth with three long, slender, feebly winged claws. Fifth and sixth legs not observed.

*Length.*—1.7 mm.

*Host.—Pseudopristipoma nigra.*

*Distribution.*—India (Kerala).

*Holotype.*—In the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2147/2.

*Remarks.*—This small, rather aberrant copepod is of much taxonomic significance. Its legs are very much like those of *Lepeophtheirus* but the cephalic appendages show close similarity to those of *Annuretes.* As in *Annuretes* the postero-median lobe of the cephalothorax slightly overlaps the fourth segment and the abodomen is much reduced. It is simply a matter of opinion whether to include it in *Anuretes* or *Lepeophtheirus.*

### **Lepeoptheirus cresseyji** (Cressey)

*Dentigryps longicauda* Cressey, 1966c, p. 91, figs. 1-13.

*Female.*—Cephalothorax as long as broad, lateral borders evenly rounded, frontal plates small but projecting, postero-median lobe twice as broad as lateral lobes and projecting. Fourth segment very broad, genital segment enlarged, broader than long, postero-laterally forming rounded lobes. Abdomen short and one-jointed. Caudal rami longer than abdomen, with four apical and two median setae. Egg tubes short.

Basal segment of antennule very stout. Process on basal segment of antenna large. Post-antennal process with a short claw and three smaller accessory claws. Post-oral process with two subequal claws. Distal segment of maxilla very long. Basal segment of maxilliped with small inner projection. Sternal form with short apically expanded diverging limbs.

Claws on distal exopod segment of first leg successively decreasing in length, spine-like seta small, as long as third claw. Claws on exopod of second leg large, endopod segments hairy. Basal claw of exopod of second leg very large, apically blunt, accessory claw narrower, endopod one-jointed and unarmed. Fourth leg of the usual type. Fifth leg a chitinised process with three sete reaching beyond the caudal rami.

*Length.*—5.6 mm.

*Host.—Caranx hippos.*

*Distribution.*—Madagascar.

*Remarks.*—This species has several distinguishing characters like the shape of the post-antennal and post-oral processes, shape of the sternal fork, structure of the rami of the third leg and of the fifth leg and caudal rami.

The description of the third leg, if correct, shows very unusual features but one may suspect that it is not adequate. The above description is extracted from Cressey (1966a).

## Subfamily ANURETINAE

*Diagnosis.*—Cephalothorax as in Lepeophtherinae, comparatively large, postero-median lobe large, overreaching lateral lobes and produced backwards to a varying extent, hiding fourth segment and part of the genital segment. Fourth segment short. Genital segment moderately enlarged. Abdomen very short or even absent. Caudal rami small, often attached to genital segment.

Basal segment of antennule generally with a lower distal spine. Post-antennal process normal, reduced in size or absent. Post-oral process often reduced. Maxillule shifted far in front of post-oral process. Maxilla with or without 'whip' near its base. Sternal fork present or absent.

Spine-like seta on distal segment of first leg placed between the second and third claws. Endopod segments of second leg hairy,

rarely spiny. Rami of third leg overlapping, exopod composed of one segment in addition to the claw. Fourth leg reduced in size and armature, generally three-segmented.

*Discussion.*—This subfamily as treated here is very much different from that proposed by Yamaguti. He included only *Anuretes* and *Pseudanuretes* in Anuretinae. *Heniochophilus* which is most closely related to *Anuretes* was placed in Lepeophtherinae. *Mappates* which has the closest resemblance to *Heniochophilus* was placed in a new subfamily Mappatinae, obviously relying on the faulty description of the type species by Rangnekar. Yamaguti placed *Eirgos* in a new family Erigidae. But Ho has shown that *Eirgos* is a synonym of *Anuretes* and that *E. annurus* is probably the same as *A. heckeli.* Family Eirgidae and Subfamily Mappatinae are not valid and the species they contained should be transferred to Anuretinae.

*Anuretes*, *Pseudanuretes*, *Heniochophilus* and *Mappates* must come under Subfamily Anuretinae as in all fundamental characters they show very close similarity. In all these genera the cephalothorax is comparatively large and its postero-median lobe is produced backwards to a varying extent, most in *Mappates* and least in *Anuretes* (it is very large in *A. menehune* and *A. heckeli*). The genital segmet is enlarged and the abdomen shows progressive degeneration ending in its total absence. However in all the caudal rami are normally developed. The basal segment of the antennule is identical and there is a lower distal spine. The post-antennal process may be normal, reduced in size or totally absent. The post-oral process is reduced (modified in *Mappates*) and the maxillule is shifted forwards. The sternal fork may be present or absent.

In contrast to the above characters, some of which are variable, the legs show near uniformity. The first leg is exactly the same in all, with the unusual feature that the spine-like seta on the distal segment is placed between the second and third claws. The rami of the third leg are two-jointed and overlap, exact duplicates of those of *Anuretes.* The fourth leg however shows progressive reduction.

From the above it can be seen that the four genera differ from one another mainly in some negative characters, namely, the absence of post-antennal and post-oral processes and the sternal fork. In well known genera like *Caligus*, *Dissonus* and *Anuretes* these characters show much variation. But this has not been used as generic discriminants. Among caligids the fourth leg shows all grades of degeneration, for example, *Abasia*, *Heniochophilus*, *Pseudocaligus*, *Pseudolepeophtheirus* and *Caligodes*. As observed by Kabata (1965a) the presence or absence of the fourth leg has no more than specific value unless there are other discriminating characters. In the four genera under discussion similarities outweigh differences. It is perhaps significant that in Indian waters members of all these genera parasitise a single species of host namely *Platax teira*. Can it be that these genera are exhibiting adaptive convergence of a remarkable nature ?

The validity of these genera has been discussed by Shiino (1954b) Pillai (1967c), Kabata (1965a), Ho (1970b) and Hameed and Pillai (1973b). But only Shiino has suggested any kind of solution. One possibility is to sink all these in *Anuretes* and fill the "waste basket" as Shiino described it. *Anuretes* will then contain about twenty five species which can be divided into subgenera. The species could be grouped into two, one with sternal fork and the other without it. But each subgenus will be a heterogeneous assemblage of species without close affinity. But it cannot be a retrogressive step as none of these genera at present has homogenity.

Some of the well known caligid genera indeed pose a problem for taxonomists. Based on the shape of the genital segment and abdomen I divided *Parapetalus* into two genera removing two species to *Pseudopetalus*. But a few species of *Caligus* have a body highly flattened like that of *P. hirsutus*. Actually one cannot find any dependable difference between *Caligus*, *Parapetalus* and *Pseudopetalus*. Again there is *Synestius* which differs from *Caligus* only in the presence of processes on the genital segmet. Is this alone sufficient for the creation of a new genus ? Caligid parasites, especially females, undergo modification, in response to unknown microhabitat conditions. Hence in their classification convenience must play an important part. This is actually the position at present.

*Key to genera of* ANURETINAE

1. Postero-median lobe of cephalothorax at the most covering the fourth segment and a small part of the genital segment ... ... ... ... 2
— Postero-median lobe of cephalothorax covering at least three-fourths of genital segment ... ... ... ... ... **Mappates** Rangnekar

2. Postero-median lobe of cephalothorax covering only fourth segment, sternal fork present ... ... ... ... ... **Anuretes** Heller
— Postero-median lobe of cephalothorax covering part of genital segment ... ... ... ... 3

3. Sternal fork present ... ... ... **Heniochophilus** Yamaguti and Yamasu
— Sternal fork absent ... ... ... **Pseudanuretes** Yamaguti

## Genus **Anuretes** Heller

*Anuretes* Heller, 1868, p. 186 ; Wilson, 1905a, p. 533 ; Shiino, 1954b, p. 260 ; Yamaguti, 1963, p. 67 ; Pillai, 1967c, p. 362.

*Diagnosis.*—Cephalothorax comparatively large, frontal plates moderately deep, lunules absent. Fourth thoracic segment very short, often overlapped by postero-median lobe of cephalothorax. Genital segment enlarged, but much smaller than cephalothorax. Abdomen small and one-segmented or reduced to a conical lobe making the caudal rami appear as if originating from the genital segment.

Basal segment of antennule with or without a spine-like distal process. Post-antennal and post-oral processes normal. Sternal fork present. Maxilla with or without whip-like process near its base. Legs generally as in *Lepeophtheirus*, spine-like seta on distal segment of first leg placed between second and third claws. Rami of third leg two-jointed, overlapping. Fourth leg feeble, three-jointed.

Parasites of teleosts.

Type species : *A. heckeli* Heller

*Discussion.*—This genus contains ten species, *A. heckeli* Heller, *A. parvulus* Wilson, *A. perplexus* Bassett-Smith, *A. plectorpynchi* Yamaguti, *A. quadrilaterus* Shiino, *A. renalis* Heegaard, *A. serratus* Shiino, *A. anomalus* Pillai and *A. menehune* Eewis. *A. branchialis* Rangnekar is a *Heniochophilus.*

Genus *Anuretes* includes two groups of species, one having short but distinct abdomen as in *Lepeophtheirus* and the other without abdomen and showing clear affinity to *Heniochophilus.*

*Key to species of* **Anuretes**

1. Basal segment of maxilliped with large apically acute process ... ... *perplexus* Bassett-Smith
— Basal segment of maxilliped without process ... ... ... ... ... *anomalus* Pillai

## **Anuretes perplexus** Bassett-Smith
(Fig. 155)

*Anuretes perplexus* Bassett-Smith, 1898b, p. 88, fig. 3 ; Pillai, 1969, p. 169, figs. 117-130.

*Female.*—Cephalothorax as long as broad, frontal plates prominent and projecting, postero-median lobe distally faintly concave and projecting, twice as broad as lateral lobes, posterior sinuses broad, shallow and wide open. Fourth segment small, overlapped by cephalothorax but visible. Genital segment broader than long, half as broad as cephalothorax. Abdomen very short, attached to ventral side of genital segment. Caudal rami visible in dorsal view, each with five setae.

Basal segment of antenna with a sharp process, distal segment long, apically recurved, with two setae. Post antennal process with circular base, claw strong and curved, post-oral process externally flanged. Maxilla with very slender apical processes. Basal segment of maxilliped produced into an apically acute large process, claw strongly curved. Sternal fork with short but broad base, limbs parallel and narrowing.

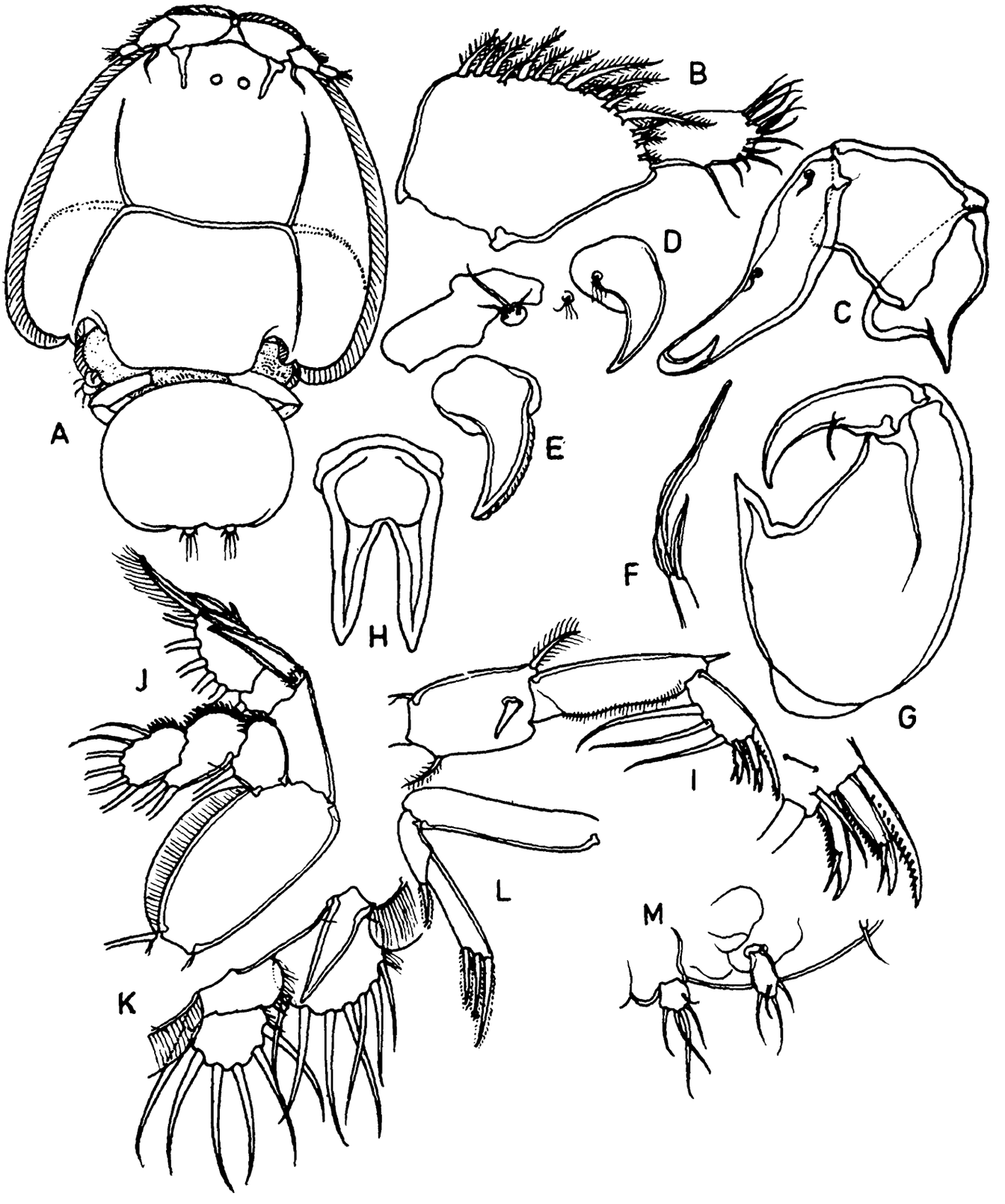


Fig. 155. *Anuretes perplexus* Bassett-Smith : A, female, dorsal view ; B, antennule ; C, antenna ; D, post-antennal process ; E, post-oral process and maxillule ; F, maxilla ; G, maxilliped ; H, sternal fork ; I-L, legs 1-4 ; M, legs 5-6 and caudal ramus.

Vestigial endopod of first leg spiniform, second exopod segment with three slender barbed claws, second and third with accessory process, spine-like seta placed between the second and third claws, lower setae normally developed. First claw of exopod of second leg large, third short, segments of endopod with a row of spinules. Basal claw of exopod of third leg stout, straight and directed inwords, rami slightly overlapping. Fourth leg three-segmented, with four feebly winged slender claws, last claw moderately long. Fifth leg composed of one and sixth of four setae placed on a process.

*Length.*—3.0 mm.

*Host.*—*Lutianus* sp.

*Distribution.*—Sri Lanka.

## **Anuretes anomalus** Pillai
(Fig. 156)

*Anuretes anomalus* Pillai, 1967c, p. 358, figs. 1-22.

*Female.*—Cephalothorax distinctly longer than broad, widening backwards, frontal plates deep but not much projecting, posteromedian lobe medially angular, nearly twice as broad as lateral lobes. Fourth segment hidden by median lobe of cephalothorax. Genital segment broader than long, two-thirds as broad as cephalothorax. Abdomen absent. Caudal rami originating directly from genital segment, very slightly longer than broad, with four small and three long setae.

Basal segment of antennule with lower distal sharp spine. Basal segment of antenna produced into a strong spine, distal segment long. Post-antennal process a stout sharply curved apically blunt claw, post-oral process with broad base, claw short. Apical claw of maxilla slender and long, "whip" with stout basal part. Basal segment of maxilliped with deep proximal incision, distal segment sharply curved, constricted beyond the middle and grooved along the inner border. Sternal fork broad, rami as long as base, distally rounded and slightly diverging.

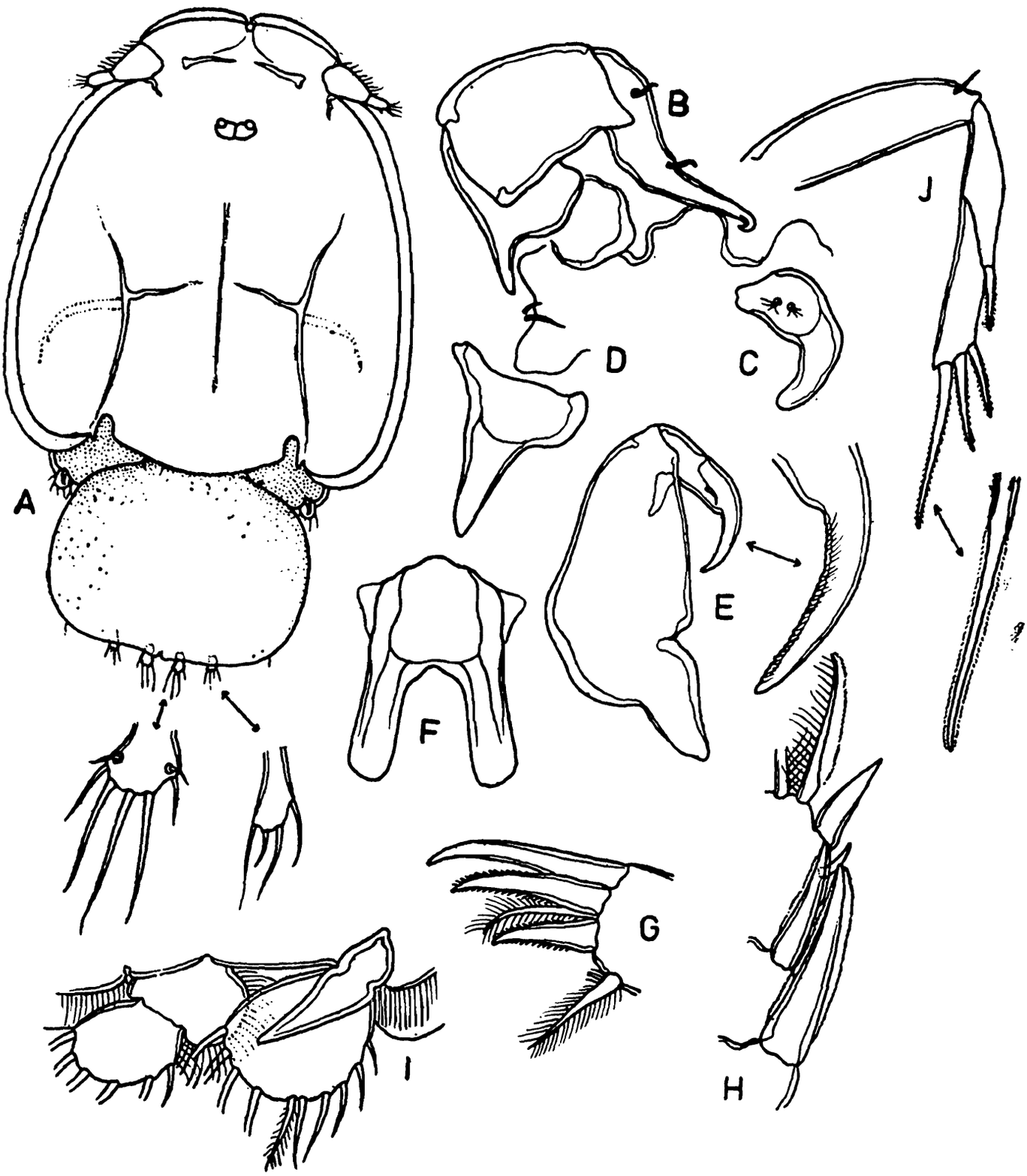


Fig. 156. *Anuretes anomalus* Pillai : A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule; E, maxilliped ; F, sternal fork ; G-J, legs 1-4.

First leg rather small, claws on distal segment stout. First claw of exopod of second leg very long, second short, third very small,

first seta short, stout and naked, endopod segments hairy. Basal claw of exopod of third leg stout and bent inwards, rami overlapping, basal segment of endopod externally expanded, velum apparently absent. Fourth leg slender, three-segmented, with weak slender claws having narrow pectinate wings. Fifth leg composed of a single seta and sixth of an elongated lobe carrying four setae. Egg tubes short.

*Length.*—3.0 mm.

*Host.—Platax teira.*

*Distribution.*—India (Kerala).

*Holotype.*—Female, in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No C 2148/2.

*Remarks.*—The total suppression of the abdomen and the presence of the maxillary whip makes this species resemble the other genera of Anuretinae very closely. The similarity is further evident in the nature of the appendages, supporting the view that *Heniochophilus*, *Pseudanuretes* and *Mappates* are in a way modified *Anuretes.*

## Genus **Heniochophilus** Yamaguti and Yamasu

*Heniochophilus* Yamaguti and Yamasu, 1959, p. 124 ; Yamaguti, 1963, p. 81 ; Pillai and Lal Mohan, p. 270 ; Kabata, 1965a, p. 22.

*Diagnosis.*—Cephalothorax comparatively very large, longer than broad, lunules absent. Postero-median lobe produced backwards, covering fourth segment and a part of the genital segment. Posterior sinuses reduced to mere slits. Fourth thoracic segment very short, hidden dorsally and ventrally. Genital segment enlarged, nearly equal in length and width, almost as broad as cephalothorax. Abdomen reduced to a conical lobe carrying the caudal rami Egg tubes short.

Basal segment of antennule with lower distal spine. Post-antennal process very small. Post-oral process small, placed alongside the tip of the oral cone. Maxillule placed far away from the post-oral process. Sternal fork well developed.

First leg with spine-like seta placed between the second and third claws. Apron of third leg enlarged, covering part of genital segment, rami overlapping. Fourth leg slender, three-segmented, with long weak claws.

Parasites of teleosts (chaetodontids).

Type species. : *H. japonicus* Yamaguti and Yamasu.

*Discussion.*—Rangnekar (1953) described a copepod collected from *Thynnus pelamys* as *Anuretes branchialis*. Later Yamaguti and Yamasu (1959) created *Heniochophilus* to describe a parasite collected from *Heniochus acuminatus*. Pillai and Lal Mohan (1965) described specimens collected from *Eleutheronema* as *Heniochophilus japonicus* and made *Anuretes branchialis* its synonym. I had an opportunity to study specimens of *H. japonicus* in the British Museum and this has shown that *H. branchialis* is a valid species. While examining *Platax teira* I collected specimens of a new species. Thus *Heniochophilus* includes three species.

*Key to species of* **Heniochophilus**

1. Post-antennal process normal, fourth leg with three claws ... ... ... ... *indicus* Pillai
— Post-antennal process very small, fourth leg with four claws ... ... ... ... ... ... 2

2. Claws on distal segment of first leg without accessory process ... ... ... *branchialis* (Rangnekar)
— Claws on distal segment of first leg with accessory process ... ... ... *japonicus* Yamaguti and Yamasu

## **Heniochophilus branchialis** (Rangnekar)
(Fig. 157)

*Anuretes branchialis* Rangnekar, 1953, p. 239, figs.; Yamaguti, 1963, p.68.
*Heniohophilus branchialis* Pillai and Lal Mohan, 1965, p. 270, figs. 1-14.

*Female.*—Cephalothorax clearly longer than broad, frontal plates low, membranous flange of frontal plates and cephalothorax broad. Postero-median lobe considerably enlarged and produced

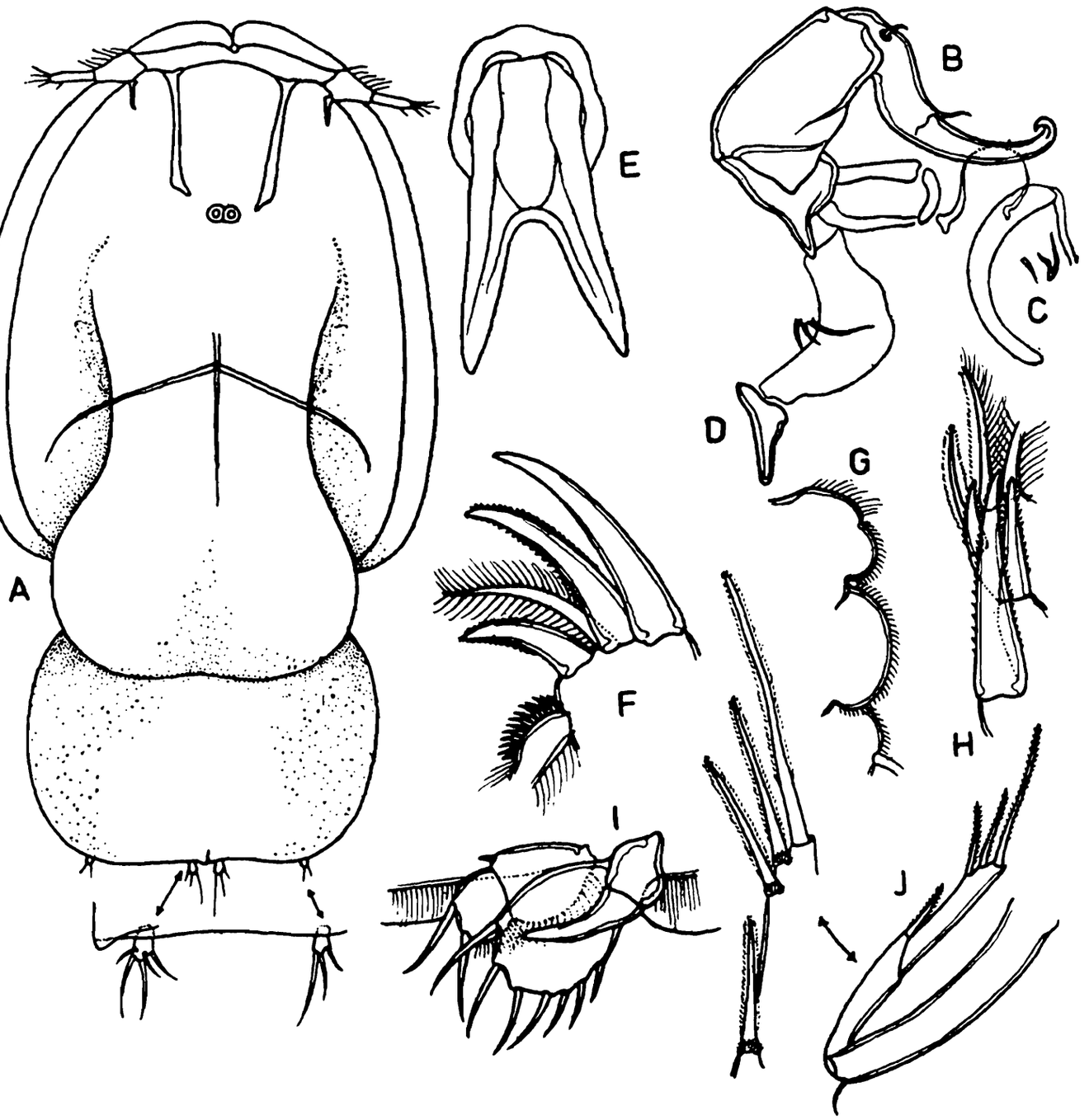


Fig. 157. *Heniochophilus branchialis* (Rangnekar) : A, female, dorsal view ; B, antenna ; C, post-antennal process ; D, post-oral process and maxillule ; E, sternal fork ; F, leg 1 ; G, leg 2, endopod ; H, same, exopod ; I, leg 3 ; J, leg 4.

backwards, overlapping lateral lobes and about a third of the genital segment, its distal border medially concave. Genital segment transversely expanded, narrower than cephalothorax. Abdomen absent. Caudal rami originating from the genital segment, a small lobe with five setae.

Basal segment of antennule with lower distal acute spine. Basal segment of antenna produced into a large apically rounded process, third segment long, apically recurved. Post-antennal process a very small curved claw, post-oral very small. Maxillule composed of one long and two short setae placed midway between the antennae and post-oral processes. Distal segment of maxilla long and slender, apical claw very long. Basal segment of maxilliped stout, with inner proximal incision, distal segment a strongly curved claw. Base of sternal fork as long as limbs, latter narrowing and diverging.

Distal segment of first leg with three long setae, claws large and barbed, without accessory process. First claw of exopod of second leg very stout, straight, clearly overreaching third segment. Segments of endopod with short stiff hairs. Basal claw of exopod of third leg stout and slightly curved, second segment of exopod large and overlapping endopod, velum absent. Fourth leg slender, basal segment longer than rest of limb, second segment with one and third with three long slender feebly winged claws.

*Length.*—1.7 mm.

*Host.—Platax teira, Eleutheronema tetradactylum.*

*Distribution.*—India (Bombay, Kutch, Kerala),

*Remarks.*—This species closely resembles *H. japonicus* but can be distinguished by a combination of characters. In *H. japonicus* the posterior sinuses of the cephalothorax though small are visible but they are absent in *H. branchialis*. The cephalothorax has an antero-lateral constriction in *H. japonicus*. This is absent in *H. branchialis*. The limbs of the sternal fork are apically more acute in *H. branchialis*. The second and third claws of the first leg have accessory claws in *H. japonicus*, they are absent in *H. branchialis*. The first claw of the exopod of the second leg overreaches the third segment in *H. branchialis* but is shorter in *H. japonicus*.

According to Yamaguti (1963) the post-antennal process is absent in *Heniochophilus* and Kabata makes no mention of it. This process though very small is actually present in all the three species

known. The close similarity between *H. branchialis* and *Anuretes anomalus* is particularly significant.

## **Heniochophilus indicus** Pillai
(Fig. 158)

*Heniochophilus indicus* Pillai, 1977, p. 55, figs. 15-29.

*Female*.—Cephalothorax gradually widening backwards, longer than broad. Antero-lateral borders with a pair of incisions. Frontal plates deep and projecting, with narrow flange. Postero-median lobe twice as broad as lateral lobes. Posterior sinuses though small, clearly visible. Genital segment narrowing backwards, equal in length and width, three-fourths as broad as cephalothorax. Abdomen, though fused with genital segment, clearly visible. Egg tubes nearly as long as cephalothorax.

Basal segment of antennule only slightly longer than broad, lower distal process apically bifid, setae long and well spaced. Basal segment of antenna with small apically rounded process, distal segment with two setae. Post-antennal process normally developed, with large base and curved blunt claw. Post-oral process elongate triangular, with a small accessory process on inner side. Distal segment of maxilla longer than basal, swollen in the middle, apical claw long, subapical short. Basal segment of maxilliped conically produced, claw well curved, with basal spine. Base of sternal fork progressively widening, limbs apically rounded and diverging.

Vestigial endopod of first leg pyriform, carrying an apical spine. Distal segment of exopod with three slender smooth claws, a plumose spine-like seta and three long setae, second and third claws with very small accessory process making them appear bifid. First claw on exopod of second leg reaching far beyond the third segment, second just overreaching third segment, third short and slightly curved, first seta stout but not winged. Segments of endopod with short stiff setules. Exopod of third leg composed of two segments in addition to the claw, second segment of endopod with four setae. Fourth leg very small, three-jointed, basal segment as long as third, with long lower distal seta, second with one and third with two spines.

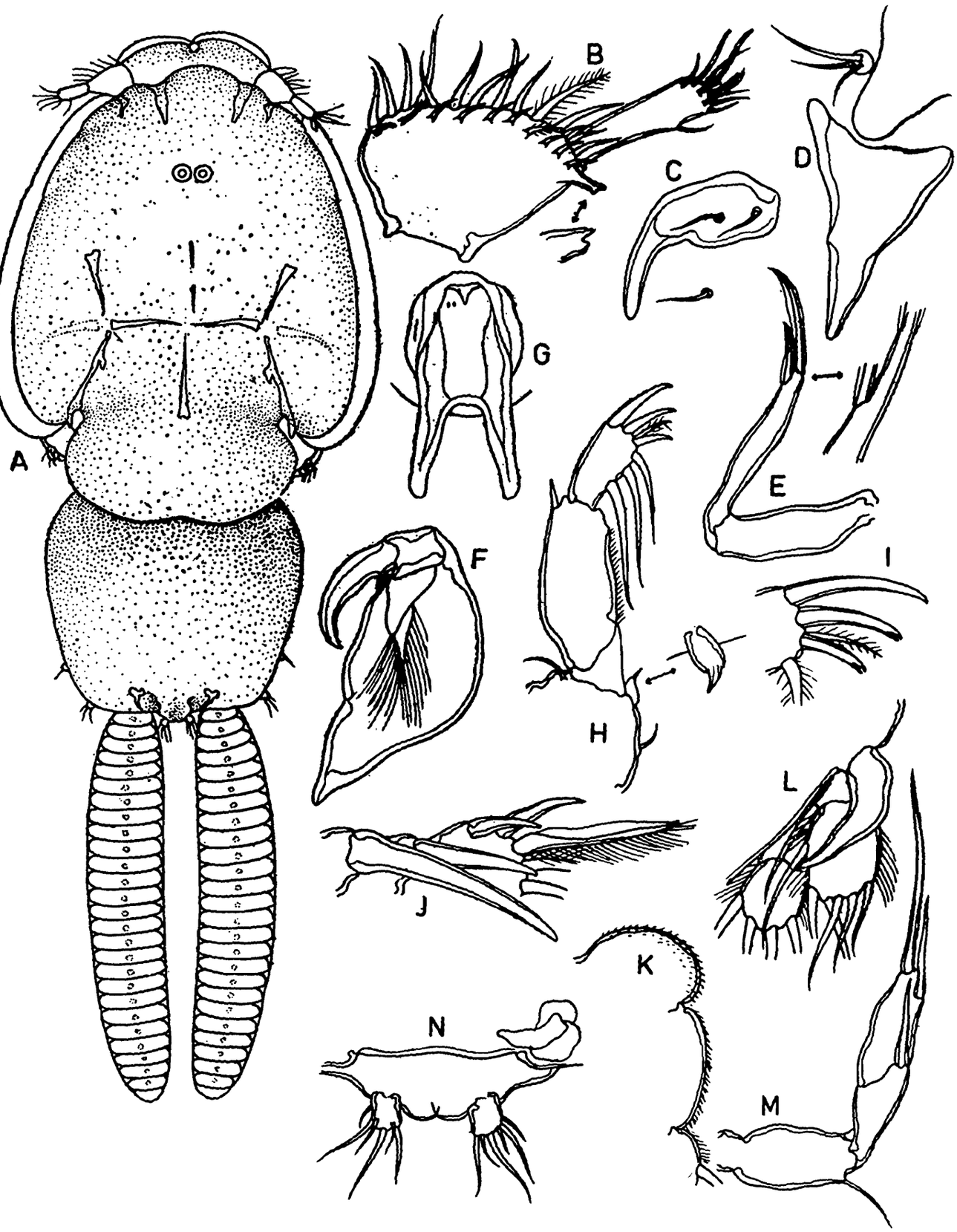


Fig. 158, *Heniochophilus plataxus* sp. nov. A, female, dorsal view; B, antennule; C, post-antennal process ; D, post-oral process and maxillule; E, maxilla ; F, maxilliped ; G, sternal fork ; H, leg 1 ; I, same, tip enlarged; J, leg 2, exopod ; K, same, endopod ; L, leg 3; M, leg 4 ; N, abdomen and caudal rami.

*Length.*—2.1 mm.

*Host.—Platax teira.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey India, Calcutta. Reg. No. C 2149/2.

*Remarks.*—This species breaks down the gap between *Anuretes* and *Heniochophilus*. The cephalic appendages are like those of *A. anomalus* but the thoracic appendages resemble those of *H. branchialis*. In overall shape *H. indicus* resembles *Pseudanuretes schmidti* Rangnekar. But the latter is described as lacking the sternal fork. The armature of the legs is very characteristic and distinguishes *H. indicus* from all the other parasites of *Platax teria.*

## Genus **Pseudanuretes** Yamaguti

*Pseudanuretes* Yamaguti, 1936b, p. 17; 1963, p. 68 ; Kabata, 1965a, p. 25 ; Pillai, 1967c, p. 362; Lewis, 1968, p. 33.

*Diagnosis.*—Cephalothorax like that of *Anuretes* and *Heniochophilus*, postero-median lobe moderately produced over genital segment, slightly more than in *Anuretes* and less than in *Heniochophilus*. Posterior sinuses absent. Fourth segment hidden. Genital segment swollen but much narrower than cephalothorax. Abdomen reduced as in *Anuretes* and *Heniochophilus*. Post-antennal process absent (present in *P. schmidti*). Post-oral process present. Maxillule as in *Heniochophilus*. Sternal fork absent. Fourth leg normal or reduced. Other appendages as in *Anuretes*.

Parasites of teleosts.

Type species. : *P. chaetodontis* Yamaguti.

*Discussion.*—This genus contains four species, *P. chaetodontis* Yamaguti, *P. schmidti* Rangnekar, *P. fortipedis* Kabata and *P. pomacanthi* Eewis. According to Kabata *P. schmidti* differs from the others in the presence of post-antennal process and the absence

of the maxillary whip. The post-antennal process though small is present in *P. fortipedis* and evident in *P. pomacanthi.* It may be pointed out that neither Yamaguti and Yamasu nor Kabata observed the post-antennal process in *Heniochophilus japonicus.* It is present in the specimens deposited in the British Museum. The presence of the maxillary whip is not a unique character of *Pseudanuretes* since a similar structure is present in *Anuretes anomalus.*

*Key to species of* **Pseudanuretes**

| | | |
|---|---|---|
| 1. | Third segment of antenna with accessory process ... ... ... ... ... ... | 2 |
| — | Third segment of antenna without accessory process ... ... ... ... ... ... | 3 |
| 2. | Fourth leg composed of a short segment carrying one seta ... ... ... | *chaetodontis* Yamaguti |
| — | Fourth leg composed of two segments, leg almost normally developed ... ... | *fortipedis* Kabata |
| 3. | Fourth leg straight, short, two-jointed, with two unequal distal setae ... ... ... | *schmidti* Rangnekar |
| — | Fourth leg bent, three-jointed, with two distal subequal setae ... ... ... | *Pomacanthi* Lewis |

## **Pseudanuretes schmidti** Rangnekar

*Pseudanuretes schmidti* Rangnekar, 1957a, p. 10, fig. 2 ; Yamaguti, 1963, p. 69, pl. 48, fig. 4.

*Female.*—Cephalothorax elliptical, with narrow membranous flange. Frontal plates low but broad, with narrow flange. Postero-median lobe enlarged, produced over fourth segment and part of genital segment, about four times as broad as lateral lobes, prsterior sinuses not visible. Genital segment roughly circular. Abdomen indicated by a narrow bilobed projection. Caudal rami with two long and three short setae. Egg tubes short, with very few eggs.

Basal segment of antennule with long setae, lower distal spine sharp. Antenna weak, basal process blunt, distal segment slender, bent at right angles in the middle. Post-antennal process very small. Post-oral process absent. Maxillule represented by two

setae. Maxilla slender, distal segment with long apical and short subapical claws. Maxilliped normal. Sternal fork absent.

Distal segment of first leg with three claws and three long setae, spine-like seta placed between second and third claws. First claw of exopod of second leg overreaching tip of third segment, other claws short, subsimilar, endopod segments unarmed. Rami of third leg overlapping. Fourth leg reduced to a two-jointed stump, second segment with one long and one short seta.

*Length.*—1.7 mm.

*Host.—Platax teira.*

*Distribution.*—India (Bombay).

*Remarks.*—This species differs from *P. chaetodontis* and *P. fortipedis* in the absence of accessory process on the distal segment of the antenna and from *P. pomacanthi* in the shape of the fourth leg. In the latter species the fourth leg is three-jointed and flexed as usual, with two apical subsimilar setae. *P. schmidti* needs a re-description but I could not secure a specimen for study. This description is based on the original description.

## Genus **Mappates** Rangnekar

*Mappates* Rangnekar, 1958, p. 303 ; Yamaguti, 1963, p. 86; Kritisinghe, 1964, p. 77 ; Kabata, 1964b, p. 648 ; Hamed and Pillai, 1973b, p. 408.

*Diagnosis.*—Cephalothorax perfectly oval in outline, postero-median lobe large, partly or fully covering genital segment and abdomen. Frontal plates low, without lunules. Dorsal transverse rib shifted to base of median lobe, in line with the posterior sinuses, latter small but visible. Fourth segment small, fully hidden. Genital segment enlarged, broader than long, postero-laterally produced. into prominent lobes carrying the vestigial legs. Abdomen absent Caudal rami prominent, originating from genital segment.

Basal segment of antennule with lower distal spine. Post-antennal process present but very small. Post-oral process in the shape of

a conical pad. Sternal fork absent. First leg as in *Heniochophilus*, third with very large apron, fourth small, two-jointed, distal segment with five slender claws.

Parasites of teleosts (chaetodontids).

Type species : *M. plataxus* Rangnekar.

*Discussion.*—Rangnekar described the abdomen of *M. plataxus* as two-jointed. Relying on this Yamaguti created a new subfamily Mappatinae. Kirtisinghe pointed out that the abodomen of *M. plataxus* is composed of only a single segment and also transferred it to *Eirgos* Bere (1936). This was done on the assumption that the third thoracic segment of *M. plataxus* is free. Ho (1970b) showed that in *Eirgos* the cephalothorax is composed of the cephalon and the first three thoracic segments and that the fourth segment is free. He even suggested that *E. anurus* is the same as *A. heckeli* Kroyer.

A comparison of *Mappates* with *Anuretes*, *Pseudanuretes* and *Heniochophilus* shows that notwithstanding some differences they are closely related and form a natural group. All are parasites of chaetodontid fishes. The main difference concerns the fourth leg. But ever since the cephalothorax got converted into an adhesive organ the fourth leg in caligids underwent modification and reduction. Hence the nature of the fourth leg has very little generic value.

*Key to species of* **Mappates**

1. Postero-median lobe of cephalothorax fully covering genital segment ... ... ... ... *alter* Kabata
— Postero-median lobe of cephalothorax only partly covering genital segment ... ... *plataxus* Rangnekar

## **Mappates plataxus** Rangnekar
(Fig. 159)

*Mappates plataxus* Rangnekar, 1958, p. 304, figs. 1-2 ; Yamaguti, 1963, p. 86, pl. 112. fig. 1 ; Hameed and Pillai, 1973b. p. 403, figs. 1-8 ; Pillai, 1977 p. 53, figs. 1-14.

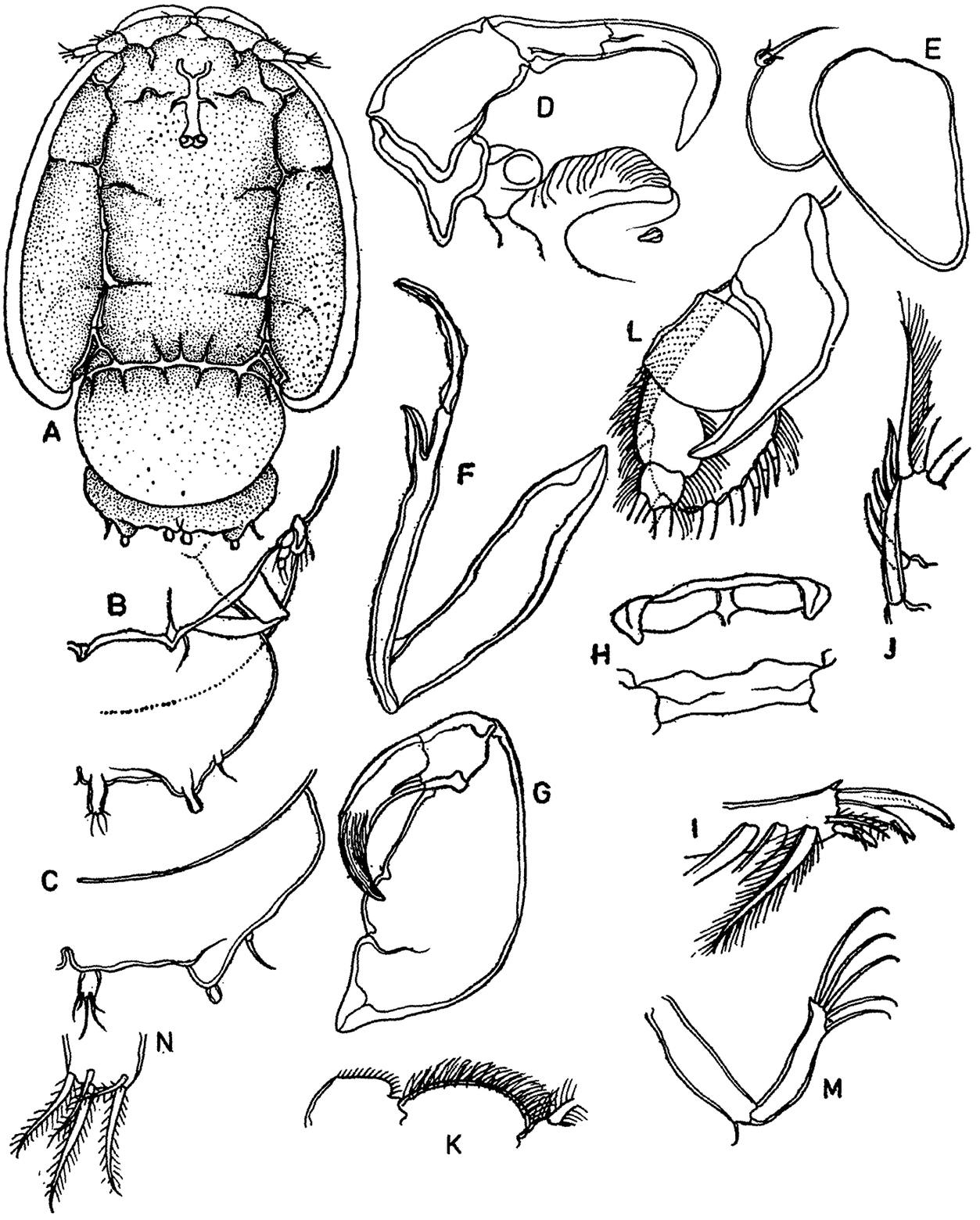


Fig. 159. *Mappates plataxus* Rangnekar : A, female, dorsal view ; B, genital segment, ventral view ; C, same, enlarged; D, antenna and post-antennal process ; E, post-oral process and maxillule ; F, maxilla; G, maxilliped ; H, intercoxal plate; I, leg 1 ; J, leg 2, exopod ; K, same, endopod ; L, leg 3; M, leg 4 ; N, caudal ramus.

*Female.*—Cephalothorax oval in outline, frontal plates low but somewhat projecting, with moderately broad membranous flange, that of cephalothorax fairly broad. Dorsal surface demarcated into three longitudinal divisions by two irregular longitudinal ribs, median division twice as broad as lateral. Postero-median lobe large, roughly semicricular and covering about two-thirds of the genital segment. Lateral lobes small. Posterior sinuses very small but dorsally visible. Fourth segment free, covered both dorsally and ventrally. Genital segment nearly twice as broad as long, bulging medially and postero-laterally produced into conical apically rounded lobes carrying the vestigial fifth and sixth legs. Abdomen represented by a medially incised lobe carrying nearly squarish caudal rami, each ramus with five fairly large setae quite unlike the usual condition in caligids.

Basal segment of antennule with lower distal sharp spine. Antenna long and slender, basal segment produced into a prominent apically rounded process, distal segment not much narrowing, with two setae, distally bent at right angles. Post-antennal process a very small chitinised structure, setules absent. Post-oral process represented by a pair of fleshy pads. Maxillule far removed from the post-oral process. Basal segment of maxilla stout, as long as distal, claws on distal segment very long, subapical claw with broad wings. Maxilliped stout, proximal segment with inner basal bluge, distal segment stout and strongly curved. Sternal fork absent, but a transverse chitinsed rib present as illustrated.

Distal segment of first leg with the usual armature, claws rapidly decreasing in length, second and third with small accessory process, spine-like seta sparsely plumose, ventral setae large. Claws on exopod of second leg successively becoming shorter, first reaching the tip of the third segment. First segment of endopod with a row of short stiff hairs, second and third with longer hairs. Basipods of third legs forming a large apron reaching the middle of the genital segment, the two longitudinal ribs reaching the hind border producing three blunt projections between which the margin of the apron is concave. Basal claw of exopod very stout, exopod one-jointed, endopod two-jointed. Fourth leg small, two-jointed, basal segment with lower distal seta, distal with five slender setiform claws successively increasing in length and placed close together.

*Length.*—3.2 mm.

*Host.—Platax teira.*

*Distribution.*—India (Bombay, Kerala), Sri Lanka.

*Holotype* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 3515/1 & C 3516/1.

*Remarks.*—The present description based on the holotype and a paratype must settle all the uncertainty regarding the characters of this species.

*M. alter* Kabata differs from *M. plataxus* in its larger postero-median cephalothoracic lobe which fully covers the genital segment, the larger postero-lateral lobes of the genital segment, in the distinct projecting abdomen and in the sharp process of the basal segment of the antenna. Kabata stated that the post-antennal process is absent in *M. alter*. But a small process is actually present in the type deposited in the British Museum.

## Family EURYPHORIDAE

*Diagnosis.*—First three thoracic segments fused with cephalon forming a cephalothorax. Frontal plates with or without lunules. Fourth thoracic segment free, with a pair of dorsal plates covering at least part of the genital segment. Genital segment large, with or without postero-lateral prolongations. Abdomen one-or two-segmented, short or long, sometimes prolonged into broad wings. Caudal rami laminate or rod-like. Body often spiny. Cephalic appendages generally as in Caligidae. Sternal fork present or absent, simple or dichotomously branched. Legs one to four biramous, or one and four uniramous, fourth much reduced in *Alebion*. Fifth leg often modified into a chitinised process.

Cephalothorax of male similar to that of female. Dorsal plates of fourth thoracic segment smaller. Genital segment small. Antenna often with accessory claw. Maxilliped with additional armature.

Parasites of elasmobranchs and teleosts.

Type genus : **Euryphorus** M. Edwards.

*Discussion.*—This family as at present constituted lacks homogenity. The only character that is common to all the genera is the presence of dorsal plates on the fourth segment. Unfortunately many species of copepods with some sort of lobes on the fourth thoracic segment were placed in this family, for example, *Midias* and *Paralebion* which do not have dorsal plates. The same is true of *Gloiopotes crassus* Wilson and Bere. In many caligids the fourth thoracic segment is drawn out and produced over the base of the legs and in others the fourth leg shows the presene of a small basal segment. But these have no similarity with the true dorsal plates of euryphorids. *Midias* is a synonym of *Caligus* and *G. crassus* is a true *Lepeophtheirus*. But *Paralebion* cannot be placed in any known genus. It cannot certainly remain in Euryphoridae. It is most closely related to *Lepeophtheirus* and has no relation to *Alebion*.

Yamaguti (1963) divided the family into Euryphorinae characterised by the absence of lunules and Tuxophorinae with lunules. In addition to having lunules *Tuxophorus* differs from the others in the nature of its thoracic limbs and is most closely related to Caliginae. Nevertheless it is doubtful whether Yamaguti's division is phylogenically sound. But it is certainly convenient.

## Subfamily TUXOPHORINAE

*Diagnosis.*—Frontal plates with lunules. Genital segment enlarged, not spiny. Abdomen one-or two-segmented, without wings or spines. Caudal rami flattened or rod-shaped. Sternal fork simple or dichotomously branched. Legs one and four uniramous, two and three biramous, fifth often a chitinised process.

Type genus : **Tuxophorus** Wilson.

*Duscussion.*—With the exclusion of *Midias* this subfamily includes only *Tuxophorus*. Six species have been described under this genus, namely, *T caligodes* Wilson (1908a), *T wilsoni* Kirtisinghe (1937a),

*T cybii* Nunes Ruivo and Fourmanoir (1956), *T solandri* Kurian (1961), *T cervicornis* Heegaard (1962) and *T tylosuri* Rangnekar (1956). *T tylosuri* is a *Caligus* and *T solandri* a synonym of *T. cybii.*

*T cybii* and *T cervicornis* differ from the others in the unbranched sternal fork and the rod-shaped caudal rami. These two characters appear to be sufficient for creating a new genus. They are therefore removed to *Tuxophoropsis* nov.

*Key to genera of* TUXOPHORINAE

| | | |
|---|---|---|
| 1. | Sternal fork dichotomously branched, caudal rami laminate ... ... ... | **Tuxophorus** Wilson |
| — | Sternal fork not dichotomously branched, caudal rami rod-shaped ... ... ... | **Tuxophoropsis** nov. |

## Genus **Tuxophorus** Wilson

*Tuxophorus* Wilson, 1908a, p. 617; Yamaguti, 1963, p. 105.

*Diagnosis.*—Cephalothorax as in *Caligus.* Frontal plates with lunules. Fourth thoracic segment with moderately large dorsal plates. Genital segment moderately enlarged. Abdomen short, one-or two-segmented. Cephalic appendages as in *Caligus.* Sternal fork dichotomously branched. Legs as in *Caligus*, basal segment of fourth leg comparatively broad. Fifth leg a long or short chitinised process.

Male with dimorphism as in Caligus.

Type species : *T caligodes* Wilson.

*Key to species of* **Tuxophorus**

| | | |
|---|---|---|
| 1. | Abdomen two-segmented, fifth leg a small chitinised lobe ... ... ... ... | *caligodes* Wilson |
| — | Abdomen one-segmented, fifth leg a long chitinised process ... ... | *wilsoni* Kirtisinghe |

## **Tuxophorus caligodes** Wilson
(Fig. 160)

*Tuxophorus caligodes* Wilson, 1908a, p. 617, pls. 55-56 ; Heegaard, 1946, p. 45 fig. 8 ; Rangnekar, 1959, p. 20, figs. 1-2 ; Pillai, 1961, p. 120, fig. 19 ; Yamaguti, 1963, p. 106, pl. 129, fig. 4.

*Female.*—Cephalothorax comparatively large, nearly equal in length and width, frontal plates low, lunules small. Postero-median lobe moderately projecting, more than twice as broad as lateral lobes, posterior sinuses moderately deep and partially closed. Fourth segment with longitudinally ovate dorsal plates situated wide apart. Genital segment highly enlarged, as long as broad, three-fourths as broad as cephalothorax, postero-laterally produced into large rounded lobes reaching the hind border of the first abdominal segment. Abdomen short, two-segmented, segments subequal in size. Caudal rami large, oblong, with comparatively short setae.

Basal segment of antennule stout, distal short. Basal segment of antenna with large flanged process, distal segment basally broad, distally curved. Post antennal process a stout broad based curved claw, post-oral process with broad base, claw strongly curved. Sternal fork with stout proximally rounded base, rami forked, limbs of the fork asymmetrical, outer being shorter.

Distal segment of first leg with three normally developed setae, claws stout and dorsally spiny, second and third with strong accessory process, spine-like seta stout and naked, claws on exopod of second leg stout, successively decreasing in size, with narrow wings, first seta spine-like and winged. Endopod segments with stiff setules. Fourth leg four-segmented, basal segment very large, claws stout, with narrow wings first four subsimilar, fifth longer. Fifth leg a short chitinised process with two setae, sixth a small process with one seta.

*Length.*—5.4 mm.

*Host.—Rachycentron canadus, Echeneis naucrates, Phycis floridanus, Tylosurus marinus, T. acus, Trachynotus cavolinus, T falcatus, Promicrops itaina.*

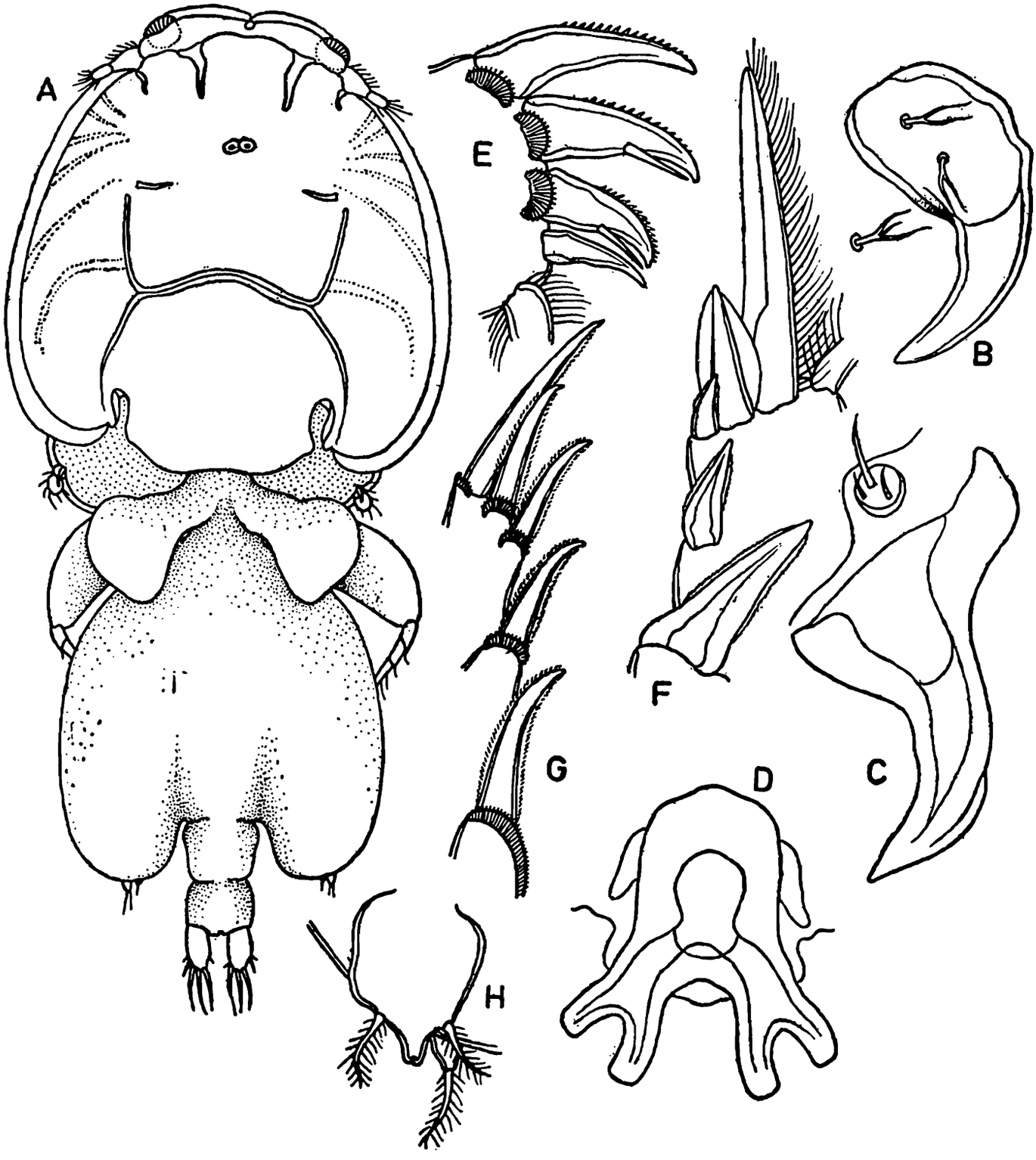


Fig. 160. *Tuxophorus caligodes* Wilson : A, female, dorsal view; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 1 ; F, leg 2, exopod ; G, leg 4 ; H, legs 5-6.

*Distribution.*—North Carolina, Louisiana, Africa, India (Kerala, Bombay).

## **Tuxophorus wilsoni** Kirtisinghe
(Fig. 161)

*Tuxophorus wilsoni* Kirtisinghe, 1937a, p. 443, figs. 59-73 ; Pillai, 1961, p. 122, fig. 20 ; 1966, p. 135, fig. 8 ; Yamaguti, 1963, p. 106.

*Female.*—Cephalothorax similar to that of *T caligodes* but slightly broader behind. Frontal plates moderately deep and projecting, lunules as deep as frontal plates. Postero-median lobe very broad, four times as broad as lateral lobes and only slightly projecting, posterior sinuses closed behind. Dorsal plates of fourth segment large, reniform and placed close together, overlapping genital segment to a greater extent than in *T caligodes*. Genital segment transversely rectangular, antero-laterally rounded and postero-laterally angular. Abdomen very short, one-segmented, basally narrow. Caudal rami longer than broad.

Antennule short but stout. Basal segment of antenna with well developed process, distal segment apically curved. Post-antennal process strongly curved, with two dorsal bulges. Post-oral process with base internally produced, claw flanged. Distal claw of maxilla very slender, twice as long as the subapical. Base of sternal fork longer than in *T caligodes*, limbs branched, branches apically broader than in *T caligodes*.

Claws on distal segment of first leg successively decreasing in length, second and third with large accessory process, spine-like seta very short. Claw of exopod of third leg strongly curved, rami placed close to each other. Basal segment of fourth leg very broad, much longer than rest of the limb, claws exactly as in *T caligodes*. Fifth leg a long chitinised apically forked process with three subapical setae and a bifid tooth carrying a seta, ventral surface with scattered denticles.

*Length.*—4.3 mm.

*Male.*—Cephalothorax slightly longer than broad, with low frontal plates and narrower postero-median lobe. Fourth segment without dorsal plates. Genital segment as in the male of *Lepeophtheirus*, with the vestigial legs on the lobes. Abdomen two-segmented, first segment short. Caudal rami well developed, longer than

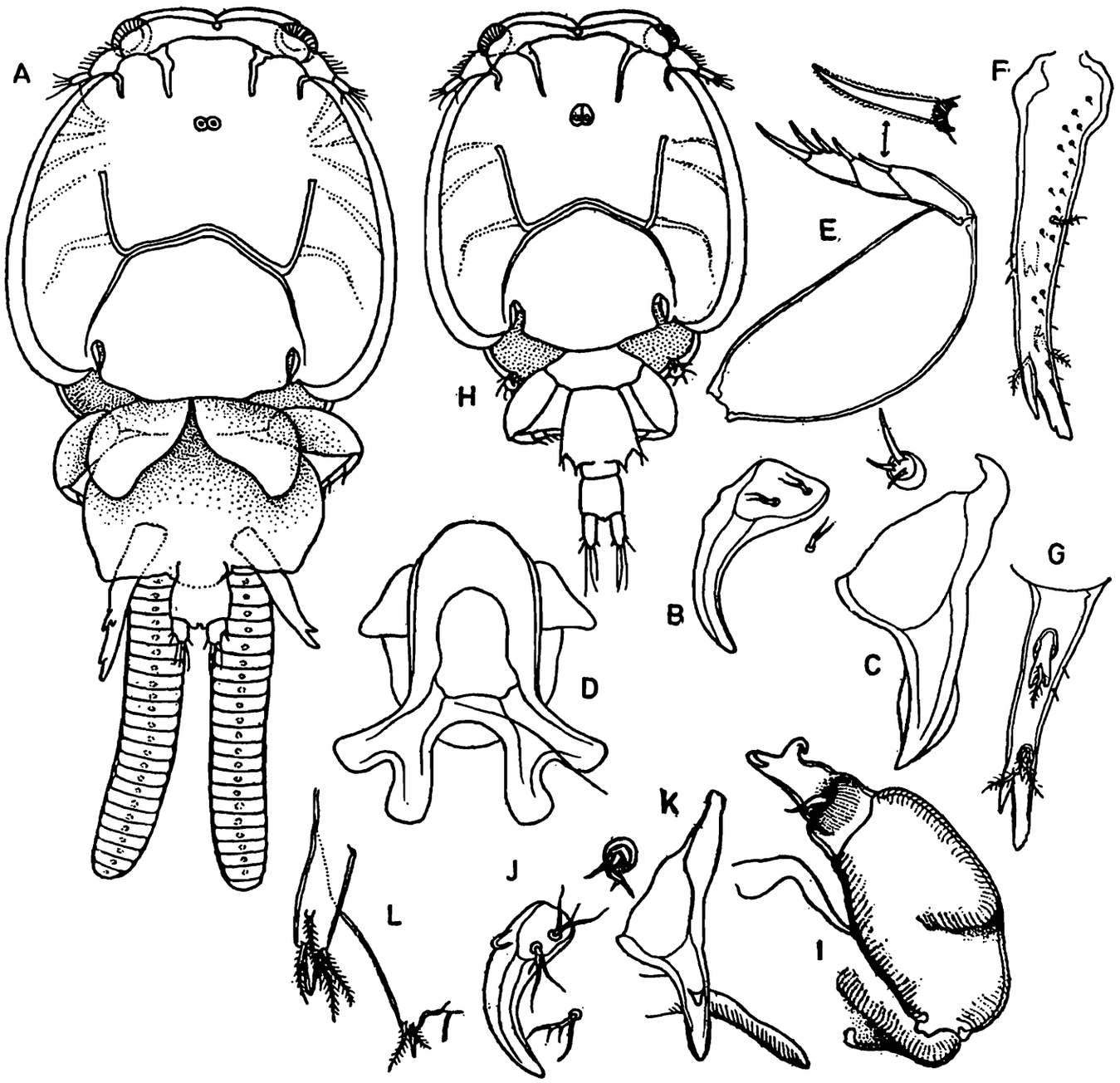


Fig. 161. *Tuxophorus wilsoni* Kirtisinghe : A-H, Female. A, female, dorsal, view ; B, post-antennal process ; C, post-oral process and maxillule ; D, sternal fork ; E, leg 4 ; F, leg 5 ; G, same, ventral view. H-L, Male. H, male, dorsal view ; I, antenna ; J, post-antennal process ; K, post-oral process and maxillule ; L, legs 5-6.

broad. First two segments of antenna stout, with adhesion pad, third short, with stout base carrying an adhesion pad, a stout process drawn out into a seta and an accessory claw. Post-antennal process stouter. Post-oral process smaller, with a small accessory process. Fifth leg a long chitinised process carrying four plumose setae and

a conical tooth. Sixth leg a conical projection carrying two setae and a spine.

*Length.*—3.1 mm.

*Host.—Chorinemus lysan.*

*Distribution.*—Sri Lanka, India (Kerala).

## Genus **Tuxophoropsis** nov.

*Diagnosis.*—Cephalothorax like that of *Tuxophorus*, but more elongated. Frontal plates less deep, lunules very small. Dorsal plates of fourth segment longer, roughly triangular. Genital segment squarish, slightly narrowing backwards. Abdomen long, indistinctly two-jointed, second segment very short. Caudal rami long, rod-shaped, without setae. Limbs of sternal fork not branched. Vestigial endopod of first leg with distal row of teeth, claws on distal exopod segment strongly barbed. Fifth leg a conical process or a large branched chitinised structure.

Parasites of teleosts (scomberoides).

Type species : *T cybii* (Nunes Ruivo and Fourmanoir).

*Key to species of* **Tuxophoropsis**

1. Fifth leg a small chitinised projection, basal segment of abdomen longer than distal. . *cybii* (Nunes Ruivo and Fourmanoir)

— Fifth leg a large process with three accessory processes, basal segment of abdomen shorter than distal . *cervicornis* (Heegaard)

### **Tuxophoropsis cybii** (Nunes Ruivo and Fourmanoir)

*Tuxophorus cybii* Nunes Ruivo and Fourmanoir, 1956, p. 76, fig. 7 ; Yamaguti, 1963, p. 106, pl. 129, fig. 3.

*Tuxophorus solandri* Kurian, 1961, p. 72, figs. 25-36.

*Female.*—Cephalothorax longer than broad, frontal plates low, not much projecting, lunules very small. Postero-median lobe

twice as broad as lateral lobes and only slightly projecting. Posterior sinuses deep, partially closed behind. Fourth segment with a pair of large, triangular dorsal plates overlapping genital segment. Latter roughly squarish, slightly narrowing backwards. Abdomen steadily narrowing backwards, two-jointed, distal segment very short. Caudal rami rod-shaped, narrowing, with outer distal projection carrying a spine, apex with two spinules, inner border with a patch of hairs.

Cephalic appendages without any special features. Sternal fork with large base, limbs short, apically acute and strongly diverging.

First leg rather stout, vestigial endopod cylindrical, its truncated apex with about eight teeth. First segment of exopod with strong upper distal spine, second with three stout claws armed on both sides with strong teeth, second and third claws with accessory process, spine-like seta naked, as long as third claw. Ventral setae increasing in length backwards. Fourth leg stout, basal segment narrower than in species of *Tuxophorus* but the rest of the limb is stouter. Claws subsimilar, with serrate flange, each with a basal row of spinules, first two rows very long. Fifth and sixth legs spiniform processes placed close together at the postero-lateral corners of the genital segment.

*Length.*—7.9 mm.

*Host.—Cybium commersoni, Acanthocybium solandri.*

*Distribution.*—Madagascar, India (Kerala).

*Remarks.*—The two descriptions of this species so far available are not complete. I could not secure a specimen for study.

## Subfamily EURYPHORINAE Wilson

*Diagnosis.*—Cephalothorax as in *Caligus*, frontal plates without lunules. Fourth segment with a pair of large dorsal plates, longer than broad, fused together or separate. Genital segment swollen with postero-lateral processes or prolongations, small or large. Abdomen linear or flattened, with small lobes or large wings.

Caudal rami laminate or rod-like. Cephalic appendages basically caligid (except in *Gloiopotes*). Sternal fork simple or branched. Legs one to four biramous (fourth uniramous in *Gloiopotes* and much reduced in *Alebion*).

Male showing dimorphism in the antenna, maxilliped and the post-cephalothoracic part of the body.

Parasites of elasmobranchs and teleosts.

Type genus : **Euryphorus** M. Edwards.

*Discussion.*—The genera contained in this subfamily show such definite characters that generic identification is easy. On the other hand specific differences are few. This is apparently the effect of the host. Members of the genus *Alebion* are exclusively parasitic on elasmobranchs, those of *Gloiopotes*, except *G. hygomianus* on bill fishes, of *Euryphorus* on *Coryphaena* and scomberoids, and of *Elytrophora* and *Caligeria* on scomberoids. Thus each genus shows strict host specificity.

*Key to genera of* EURYPHORINAE

| | | |
|---|---|---|
| 1. | Legs one to four all biramous | .2 |
| — | Legs one to four not all biramous | .3 |
| 2. | Basal segment of abdomen with large wings | **Euryphorus** M. Edwards |
| — | Basal segment of abdomen with or without small lobes, never winged | **Elytrophora** Gestaecker |
| 3. | Fourth leg uniramous, vestigial | **Alebion** Kroyer |
| — | First and fourth legs uniramous, both normal | **Gloiopotes** Stp. & Lutk. |

## Genus **Gloiopotes** Stp. & Lutk.

*Gloiopotes* Stp. & Lutk., 1861, p. 363 ; Hewitt, 1964, p. 85 ; Lewis, 1967, p. 56 ; Cressey, 1967d, p. 2.

*Diagnosis.*—Cephalon fused with first three thoracic segments forming a large cephalothorax, dorsally spiny and hairy. Frontal plates low, without lunules. Fourth thoracic segment with a pair

of large dorsal plates. Genital segment enlarged, postero-laterally produced into fleshy lobes carrying the enlarged fifth legs. Abdomen two-segmented, without lobes. Caudal rami rod-like.

Second segment of antennule with a false partition. Terminal segment of antenna claw-like. Post-antennal process with bifid accessory claw. Post-oral process bifid. Maxilla and maxilliped as in *Caligus*. Limbs of sternal fork branched or unbranched. First leg uniramous, vestigial endopod two-jointed, apical claws on distal segment of exopod forked, with an accessory process within the fork. Rami of legs two and three three-jointed, basal claw of exopod of third leg with accessory process. Fourth leg uniramous, four-jointed. Egg tubes short, eggs highly flattened.

Dorsal plates of fourth segment of male smaller and rounded. Genital segment globular, without fleshy lobes. Fifth leg rod-like. Abdomen and caudal rami longer. Antenna with accessory claw and adhesion pad. Post-antennal and post-oral processes reduced in size.

Parasites of teleosts (mainly bill fishes).

Type species : *G. hygomianus* Stp. & Lutk.

*Discussion.*—Species of *Gloiopotes* except *G. hygomianus* are parasites of istiophorids and xiphiids. *G. hygomianus* parasitises *Acanthocybium solandri* but according to Cressey (1967c) the latter shows close affinity to bill fishes and hence *Gloiopotes* can be considered as host-specific. The hosts enjoy very wide distribution and hence their parasites also enjoy almost cosmopolitan distribution. Probably because of this *Gloiopotes* spp. show much intraspecific variation making specific identification often difficult.

After a comparative study of material from all the seas Cressey concluded that the genus contains five species, namely, *G. ornatus* Wilson (1907a), and *G. americanus* Cressey (1967c) confined to the Atlantic, *G. watsoni* Kirtisinghe (1934) and *G. huttoni* (Thomson, 1889) confined to the Indo Pacific and *G. hygomianus* Stp. & Lutk. (1861) global. I accept this conclusion provisionally.

*Key to species of* **Gloiopotes**

1. Dorsal surface of body without conspicuous spinulation, limbs of sternal fork unbranced, postero-lateral lobes of genital segment overreaching fifth legs — *hygomianus* Stp. & Lutk.
— Dorsal surface of body with conspicuous spinulation, limbs of sternal fork branched, postero-lateral lobes of genital segment not overreaching fifth legs — .2

2. Genital segment longer than wide, fifth leg not reaching tip of abdomen — *.huttoni* (Thomson)
— Genital segment wider than long, fifth leg reaching tip of abdomen — *watsoni* Kirtisinghe

## **Gloiopotes watsoni** Kirtisinghe
(Fig. 162-163)

*Gloiopotes watsoni* Kirtisinghe, 1934, p. 167, figs. 1-17 ; Shiino, 1959c, p. 348 ; Yamaguti, 1963, p. 104 ; Pillai, 1964b, p. 63, figs. 14-15 ; Cressey, 1967c, p. 7, figs. 38-39.

*Gloiopotes longicaudatus* Kirtisinghe, 1964, p. 87, figs. 102-103.

*Female.*—Cephalothorax slightly longer than broad, lateral borders evenly convex, antero-medially angular. Antero-lateral areas with six rows of hairs, postero-lateral with one long marginal row. Dorsal side with scattered spines, the larger ones distributed thus :—two rows of three spines each external to the eyes, a single large spine posterior to the former, three larger spines along the inner margin of the posterior sinus, two near the hind border of the median lobe, one below the dorsal transverse rib and a row of three slightly behind. Dorsal plates of fourth segment placed at an angle with the long axis of the body, proximally produced into a rounded lobe and distally into a narrow lobe, a few anterior, three large median and a posterior arc of spines present on the plates. Genital segment hemispherical, twice as broad as long, not counting the posterior processes, with two submedian rows of three large spines. Posterior lobes irregular in outline, almost reaching the middle of the distal abdominal segment. Fifth leg processes rather flattened medially, with large spines, almost reaching the tip of the abdomen. First abdominal segment less

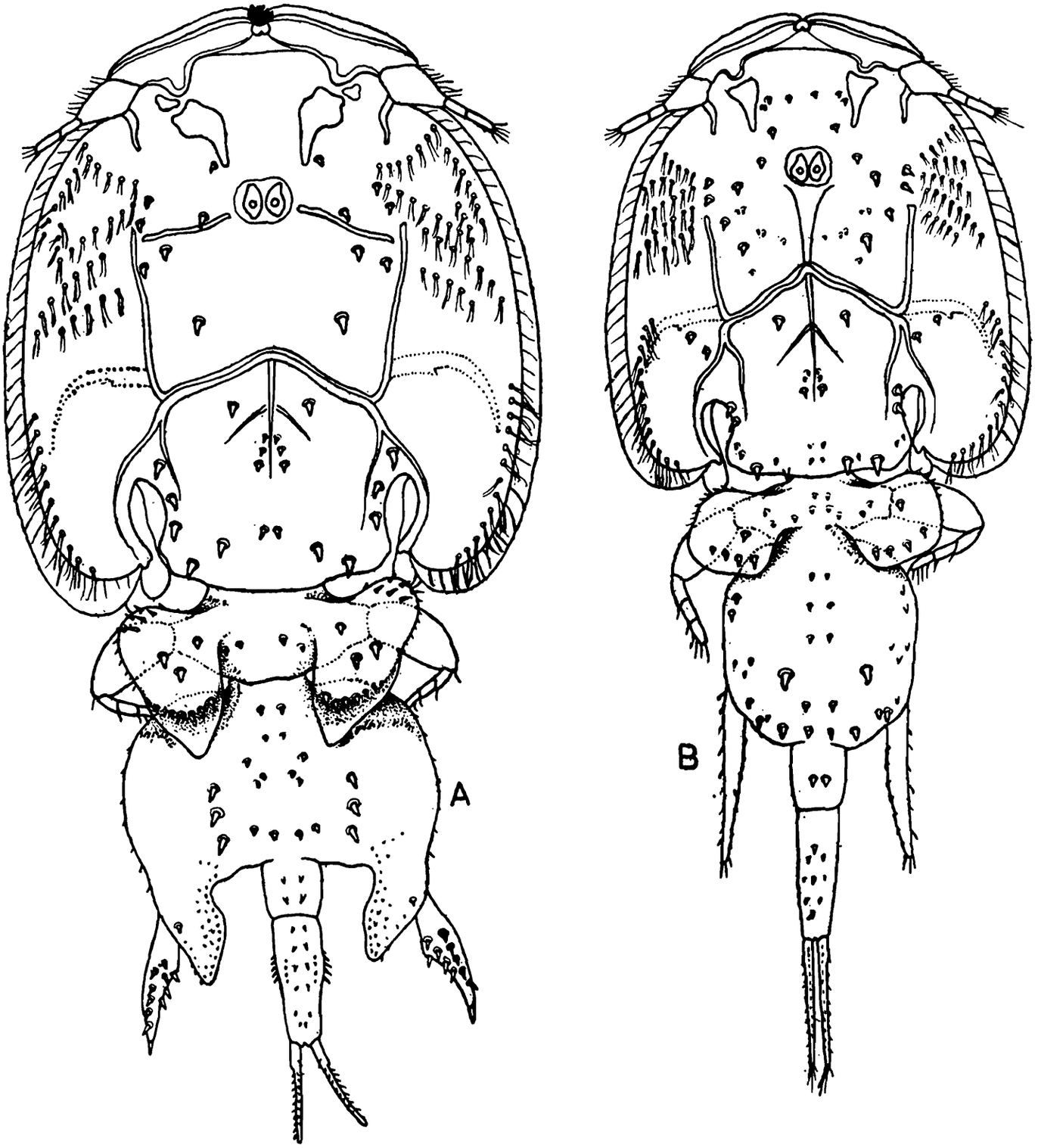


Fig. 162. *Gloiopotes watsoni* Kirtisinghe : A, female, dorsal view ; B, male, dorsal view.

than half the length of second, proximal half of latter broader. Caudal rami shorter than distal segment of abdomen, with a proximal outer kink.

Fig. 163. *Gloiopotes watsoni* (contd.) : A-J, Female. A, post-antennal process ; B, post-oral process and maxillule ; C, maxilliped ; D, sternal fork ; E, leg 1 ; F, same, endopod ; G, leg 2, exopod ; H, leg 3 ; I, leg 4 ; J, leg 5. K-N, Male. K, antenna ; L, post-oral process and maxillule ; M, maxilliped ; N, leg 5.

Post-antennal process with large conical base and stout, flanged main claw, base with asymmetrically forked large process. Post-oral

process with very broad base, produced inwards, claw stout and flanged, accessory process large. Sternal fork with long base having two pairs of processes, one short and the other long, limbs bifid.

Dorsal margin of first segment of endopod of first leg hairy, second segment very small, with three setae. Second exopod segment with second and third claws bifid with the accessory process placed within the fork, spine-like seta longer than third claw. Exopod of second leg with long outwardly bent claws, first seta claw-like. Apron of third leg reduced in size, basal claw of exopod strongly curved, with four outer spines and a large inner accessory claw, endopod three-jointed, first segment fused with the apron, second ventrally expanded. Fourth leg with strongly spiny second segment, claws with serrate wings.

*Length.*—11.4 mm.

*Male.*—Cephalothorax similar to that of female but posterolateral parts less curved. Distribution of spines generally as in female. Dorsal plates of fourth segment roughly squarish. Genital segment slightly longer than broad, with a pair of large submedian spines. Abdomen slender and two-jointed. Fifth leg long, reaching the middle of the distal abdominal segment, its apex with three stout blunt teeth. Caudal rami as long as distal abdominal segment, with two stout apical setae and two to three spines.

Second segment of antenna with an adhesion pad, third segment with two accessory processes, one small and the other large. Post-oral process without accessory claw, base internally grooved and with a small process. Basal segment of maxilliped with two low teeth and a distal bulge covered with nodules, distal segment long and slender.

*Length.*—9.0 mm.

*Host.—Histiophorus brevirostris, H. gladius, Xiphias zeugopteri, Makaira indica, M. nigricans, M. mazara, Tetrapturus mitzukur, T marlina, T audax, Istiophorus orientalis.*

*Distribution.*—Indo Pacific (India, Sri Lanka, Taiwan, Hawaii, Peru, Panama Bay, Mexico, Tahiti).

*Remarks.*—Both Hewitt (1964) and Lewis (1967) treated *G. watsoni* as a synonym of *G. huttoni* without explaining the reasons. On the other hand Cressey (1967c) upheld its validity on the ground that its genital segment and fifth legs show constant though small difference from those of *G. huttoni.* As I had no opportunity to study *G. huttoni* I am unable to express any definite opinion. However Cressey alone has made a comparative study and hence I accept his conclusion.

The original description of *G. watsoni* by Kirtisinghe does not contain details and Cressey did not give a detailed description. To facilitate future study I am giving here a detailed illustrated description.

In deciding the specific identity of many copepods the males have been found to be helpful (Ho. 1970a). I have found this ture of Pseudocycnidae. Perhaps a detailed comparison of the males of *Gloiopotes* spp. might be helpful. The cephalic appendages, especially antennae and maxillipeds, of the male show distinct difference from those of the female.

## **Gloiopotes huttoni** (Thomson)

*Lepeophtheirus huttoni* Thomson, 1889, p. 354, pl. 28, fig. 10, pl. 29, fig. 1; Wilson, 1907a, p. 701.

*Gloiopotes huttoni* Shiino, 1954c, p. 278 ; Yamaguti, 1963, p. 104 ; Hewitt, 1964, p. 86, figs. 1-16 ; Lewis, 1967, p. 57, figs. 22-24 ; Cressey, 1967c, p. 6.

*Gloiopotes longicaudatus* Shiino, 1954c, p. 273 ; Hewitt, 1964, p. 94.

*Gloiopotes costatus* Wilson, 1919, p. 313, pl. 21 ; Hewitt, 1964, p. 94.

*Gloiopotes zeugopteri* Rao, 1951, p. 248 ; Hewitt, 1964, p. 95.

*Host.—Tetrapturus audax, Makaira indica, M. mitsukuri, M. mazara, Istiophorus orientalis, Histiophorus gladius, H. herschelli, H. brevirostris, Marlina zealandica, Istiompax australis, Xiphias zeugopteri, X. gladius.*

*Distribution.*—Indo Pacific (Madras, Hawaii, Australia, New Zealand, Peru).

*Remarks.*—According to Cressey *G. huttoni* closely resembles *G. watsoni* and their identification is rather difficult. After a careful study of these two he concluded that the post-cephalothoracic part of the body shows distinct difference. In *G. huttoni* the female genital segment is longer than wide but wider than long in *G. watsoni.* The postero-lateral lobes of the genital segment reach the tip of the fifth legs in *G. huttoni* but are shorter in *G. watsoni.* The fifth leg does not reach the tip of the abdomen in *G. huttoni* while it does so in *G. watsoni.* These observations are applicable to my specimens of *G. watsoni.* But I could not study specimens of *G. huttoni.*

Both Hewitt and Lewis described this species in detail but it is surprising that their descriptions do not agree on several points. The distribution of hairs on the cephalothorax is different, so is the distribution of spines on the postero-median lobe of the cephalothorax. Lewis has illustrated the dorsal plates of the fourth segment as posteriorly produced but Hewitt has shown them as rounded. There is difference in the spinulation of the genital segment and the shape of the postero-lateral processes. Such differences are evident in the appendages also. Though Hewitt has commented on the variability of many of the specific characters his illustrations failed to bring them out clearly. Though I could not study specimens of *G. huttoni* it would appear that specimens described by Lewis might be referable to *G. watsoni* rather than *G. huttoni.*

## **Gloiopotes hygomianus** Stp. & Lutk.
(Fig. 164)

*Gloiopotes hygomianus* Stp. & Lutk., 1861, p. 363, pl. 5, fig. 9 ; Shiino, 1960c, p. 533 ; figs. 4-6 ; Lewis, 1967, p. 66, figs. 25-27 ; Cressey, 1967c, p. 8, figs. 40-42.

*Female.*—Cephalothorax regularly widening backwards, frontal plates strongly slanting making the antero-median part angular. Postero-median lobe not reaching beyond the lateral lobes, latter with a fairly long marginal row of hairs. Dorsal plates of fourth segment longitudinally rectangular, distally bilobed and overreaching the base of the abdomen. Genital segment slightly broader than long, postero-laterally drawn out into flattened lobes as long

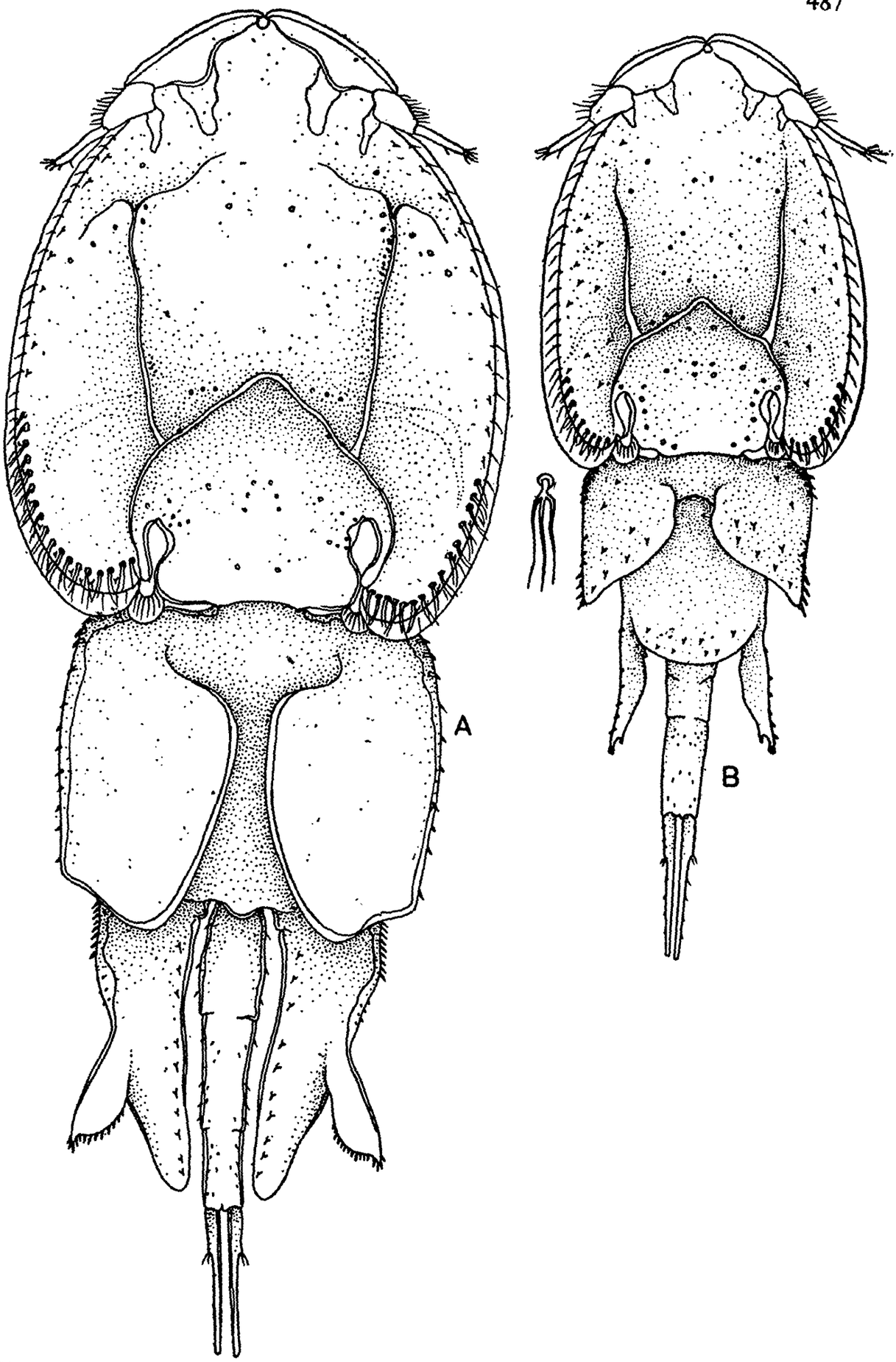


Fig. 164. *Gloiopotes hygomianus* Stp. & Lutk. : A, female, dorsal view ; B, male

as the segment proper and narrowing distalwards, apex rounded and reaching the tip of the abdomen. Fifth leg processes flattened, stopping far short of the tip of the lobes of the genital segment. Abdomen slender, two-or three-segmented, slightly narrowing distalwards. Caudal rami rod-like, slightly shorter than the second abdominal segment. Antero-lateral borders of cephalothorax, lateral borders of the dorsal plates of the fourth segment, basal outer border of the lobes of the genital segment, inner border of the genital wings and fifth legs and the abdomen with small spines. Dorsal surface of body with scattered trifid setae.

Distal segment of antennule without false partition. Basal segment of antenna with small process. Post-antennal process with small accessory process, main claw large. Post-oral process large, with small accessory process. Distal claw of maxilla slender and much longer than the subapical. Maxilliped without special armature. Sternal fork with short unbranched diverging limbs and a pair of smaller processes at their junction with the base.

Vestigial endopod of first leg two-jointed, distal segment with three setae, claws on distal segment of exopod short but stout, second and third claws forked, spine-like seta plumose on upper side. Claws on exopod of second leg short. Basal claw of exopod of third leg with small accessory process, middle segment of endopod very large and produced below the small third segment. Basal segment of fourth leg very broad, claws gradually increasing in length.

*Length.*—13.6 mm.

*Male.*—Cephalothorax comparatively longer than in female. Dorsal plates of fourth segment smaller, posteriorly drawn out and apically acute. Genital segment rounded, fifth leg comparatively slender. First segment of abdomen shorter than second. Caudal rami longer than distal segment of abdomen.

Third segment of antenna with stout accessory process. Post-oral process without accessory spine, distal segment of maxilliped drawn out into a long slender process, its base with a conical process.

*Length.*—8.2 mm.

*Host.—Acanthocybium solandri.*

*Distribution.*—Cosmopolitan.

*Remarks.*—In many of the characters this species stands isolated from the rest, no doubt due to the influence of the host which is a scomberoid.

## Genus **Euryphorus** M. Edwards

*Euryphorus* Shiino, 1954c, p. 284 ; Yamaguti, 1963, p. 98 ; Lewis, 1967, p. 31 ; Heegaard, 1972, p. 308.

*Diagnosis.*—Cephalothorax rounded, with two pairs of lateral constrictions. Frontal plates projecting, without lunules. Fourth segment with a pair of longitudinally rectangular dorsal plates. Genital segment large, slightly broader and longer than cephalothorax, with a pair of small semicircular posterior lobes overlapping the base of the egg tubes. Abdomen three-segmented, nearly as long as rest of body, first segment produced into large wings, second segment half as long as first, third very short. Caudal rami oblong, with short setae.

Post-antennal process absent. Basal segment of maxilliped with two protuberances. Sternal fork feeble. Legs one to four biramous.

Cephalothorax of male slightly longer than in female. Genital segment small, roughly oblong, longer than broad. Wings of fourth segment smaller and converging. First segment of abdomen long, with small wings. Caudal rami broader and shorter than those of female. Distal segment of antenna with accessory claw. Post-antennal process evident. Post-oral process well developed. Basal segment of maxilliped with large lobe, distal slightly curved.

Parasites of teleosts.

Type species : *E. nordmanni* M. Edwards.

*Discussion.*—Three species, namely, *E. nordmanni* M. Edwards (1840), *E. nympha* Stp. & Lutk (1861) and *E. coryphaenae* Kroyer (1863) have so far been described under this genus. All parasitise a widely distributed genus of fish, *Coryphaena*. Lewis discussed the synonymy of these species in detail and concluded that there is only one species, *E. nordmanni*. This view was upheld by Heegaard (1972).

Heegaard came to the conclusion that all the species of *Dysgamus* so far described are juveniles of *Euryphorus* or *Elytrophora*. He made the following synonyms of *E. nordmanni* :—*D. atlanticus* Stp. & Lutk (1861), *D. errans* Kroyer (1863), *D. murrayi* Brady (1883), *D. ariomus* Wilson (1907a), and *D. pacificus* Wilson (1950). This suggestion appears correct. But it is rather difficult to accept that *Elytrophora* should be placed in the synonymy of *Euryphorus*.

### **Euryphorus nordmanni** M. Edwards
(Fig. 165)

*Euryphorus nordmanni* M. Edwards, 1849, p. 462, pl. 39, fig. 1 ; Kirtisinghe, 1937a, p. 445, figs. 74-84 ; Lewis, 1967, p. 32, figs. 12-15.
*Euryphorus nympha* Stp. & Lutk., 1861, p. 365, pl. 6, fig. 12 ; Shiino, 1954c, p. 284, figs. 5-6 ; Kirtisinghe, 1964, p. 88, fig. 104 ; Pillai, 1964b, p. 64, fig. 16.
*Euryphorus coryphaenae* Kroyer, 1863, p. 161, pl. 10, fig. 4.

*Female.*—Cephalothorax slightly broader than long, rounded, with three pairs of lateral constrictions. Frontal plates short, projecting, with narrow flange. Postero-median lobe only slightly broader than lateral lobes, latter curving inwards. Fourth segment fairly large, broader than long, with a pair of longitudinally rectangular dorsal plates overlapping the genital segment. Latter clearly broader than long, short-elliptic, with a pair of short distally rounded lobes exactly above the origin of the egg tubes. Abdomen very long, three-jointed, first segment laterally drawn out into large wings regularly broadening to the hind end of the segment and further on narrowing to end behind the caudal rami, edge of the wings thickened. Second segment nearly half the length of first, third very short. Caudal rami oblong, each with four short setae.

Basal segment of antenna with acute process, distal segment apically bent. Post-antennal process absent but the bunches of

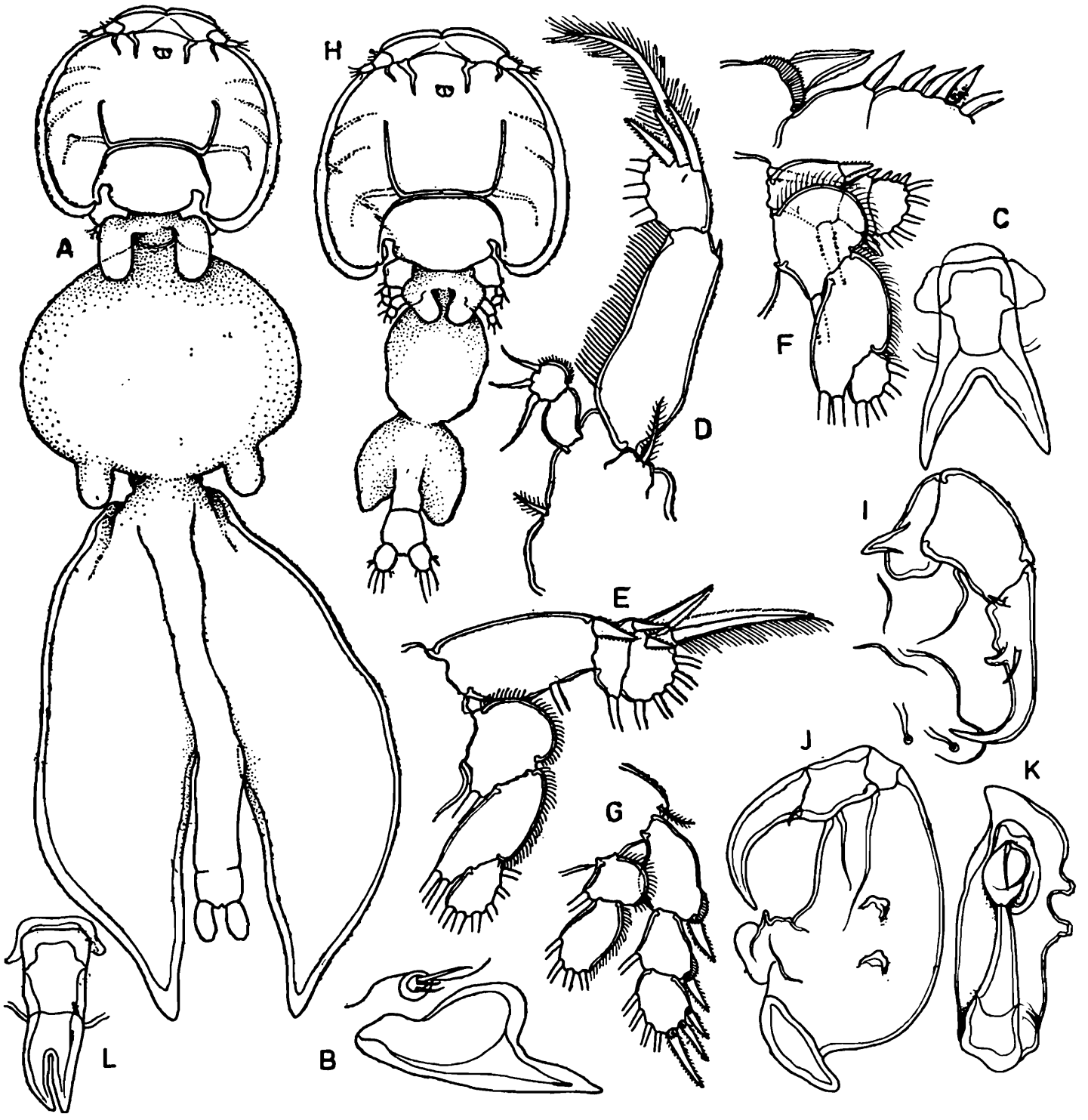


Fig. 165. *Euryphorus nordmanni* M. Edwards : A-G, Female. A, female, dorsal view ; B, post-oral process and maxillule ; C, sternal fork ; D, leg 1 ; E, leg 2 ; F, leg 3 ; G, leg 4. H-L, Male. H, male, dorsal view ; I, antenna ; J, maxilliped ; K, same, lateral view ; L, sternal fork.

hairs present. Post-oral process triangular, claw short. Maxilliped with a pair of processes on outer surface of basal segment. Sternal fork with narrow base, limbs as long as base, distally diverging.

Endopod of first leg small, two-jointed, basal segment naked, distal spiny, with three setae, distal exopod segment with three subsimilar serrate blunt claws, a very long stout plumose spine-like seta and three long setae. Distal two segments of exopod of second leg broad, outer claws short but stout. Exopod of third leg three-segmented, claw absent, first two segments of endopod expanded. Endopod of fourth leg two-jointed, exopod three-segmented, with five claws, all the claws winged, with a basal crest of spinules.

*Length.*—8.4 mm.

*Male.*—Cephalothorax longer than broad, frontal plates broader but less projecting, lateral lobes not curving inwards, median lobe somewhat angular. Dorsal plates of fourth segment narrowing and converging. Genital segment longer than broad, roughly oblong, with slight constriction in the middle. First segment of abdomen with small wings, produced backwards up to the hind border of the second segment, third segment longer than second, broadening. Caudal rami as long as broad.

Distal segment of antenna with accessory claw. Maxilliped massive, basal segment with large irregular process, distal segment strongly curved. Sternal fork with slightly deformed parallel limbs.

*Length.*—5.2 mm.

*Host.*—*Coryphaena hippurus*, *C. equisetis*, *Neothunnus macropterus*, *Lampugus punctulatus*.

*Distribution.*—Cosmopolitan.

## Genus **Elytrophora** Gestaecker

*Elytrophora* ; Wilson, 1932, p. 416 ; Shiino, 1954c, p. 279 ; 1958, p. 105 ; Yamaguti, 1963, p. 102 ; Lewis, 1967, p. 42 ; Heegaard, 1972, p. 308 (*Euryphorus*).

*Diagnosis.*—Cephalothorax comparatively large, with broad incurving postero-lateral lobes overreaching the median lobe, lateral border with prominent median notch continued inwards

as transverse grooves. Frontal plates small, fairly projecting. Fourth thoracic segment with a pair of large roughly rectangular dorsal plates fused together and posteriorly touching. Genital segment rather small, longer than broad, with small but distinct postero-lateral lobes. Abdomen two-segmented, first segment with small postero-lateral lobes. Caudal rami laminate, with small setae.

Cephalic appendages as in *Euryphorus*. Post-antennal process absent. Maxilliped rather slender. Sternal fork slender, with short limbs. Legs one to four biramous, rami of first two-jointed, of second and third three-jointed, endopod of fourth two-jointed.

Cephalothorax of male narrower. Dorsal plates of fourth segment nearly as long as broad. Genital segment and abdomen without lobes. Third segment of antenna and post-oral process with accessory process. Basal segment of maxilliped with large basal process.

Parasites of teleosts (scomberoides).

Type species : *E. brachyptera* Gestaecker.

*Discussion*.—Five species have been described under this genus, namely, *E. brachyptera* Gestaecker (1853), *E. atlantica* Wilson (1932), *E. coryphaenae* Pearse (1952), *E. hemiptera* Wilson (1921) and *E. indica* Shiino (1958b). Much discussion has already taken place regarding the synonymy of the species. *E. coryphaenae* Pearse is an young male of *Euryphorus nordmanni*. After studying the types Heegaard came to the conclusion that only one species, namely, *E. brachyptera* actually is valid and that all the others are its synonyms. This may well be so considering the near identity in the characters. But as proposed by Hewitt it is likely that several subspecies of *E. brachyptera* exist especially since this species has a global distribution. I am not expressing a definite opinion since I had the opportunity to study only a female of *E. hemiptera* and a male and a female of *E. indica* kindly gifted by Dr. Shiino.Both were collected from the Bay of Bengal. As these two seem to show some difference both are described as separate species.

Heegaard considered *Elytrophora* as a synonym of *Euryphorus*. It has to be conceded that the two genera show extreme similarity

in the nature of practically all the appendages. But the shape of the body is totally different and cannot simply be ignored. Whether the shape of the body has generic value may be controversial but in the existing system of copepod classification it has been given much importance. If otherwise several caligid genera like *Parapetalus*, *Pseudopetalus*, *Synestius*, *Echetus*, *Parechetus*, *Sciaenophilus* and *Abasia* will have to be abandoned. The axe will certainly fall on many genera created by Heegaard himself, for example, *Caligulina* and *Caligulus*. A comparison of the males of these genera now placed in Caliginae shows a monotonous uniformity in characters indicating that the shape of the female body is the result of adaptation. But it has some importance in classification.

Heegaard figured and described at length the sternal furca and secondary furca. There has been mention of secondary furca in other copepods like *Paralebion elongatus* also. I have carefully studied the two species of *Elytrophora* and find that there is a typical sternal furca. Anterior and posterior to the true furca there are paired chitinous outgrowths giving attachment to powerful muscles. These cannot be considered as furca and are not connected with the true furca as illustrated by Heegaard. I am convinved that *Euryphorus* and *Elytrophora* have a typical furca as in caligids.

*Key to species of* **Elytrophora**

1. First segment of abdomen with postero-lateral lobes ..... *.indica* Shiino
— First segment of abdomen without postero-lateral lobes ..... *hemiptera* Wilson

## **Elytrophora hemiptera** Wilson
(Figs. 166, 167 A-E)

*Elytrophora hemiptera* Wilson, 1921, p. 4, pl. 2, figs. 13-19 ; Shiino, 1958b, p. 105 ; Yamaguti, 1963, p. 103, pl. 123, fig. 2.
*Elytrophora brachyptera* Yamaguti, 1936b, p. 3, pl. 2, figs. 18-19 ; Shiino, 1954c, p. 279, figs. 3-4.

*Female*.—Cephalothorax nearly circular, with prominent medina lateral incision continued as a distinct transverse groove. Frontal plates narrow and somewhat projecting. Postero-lateral lobes

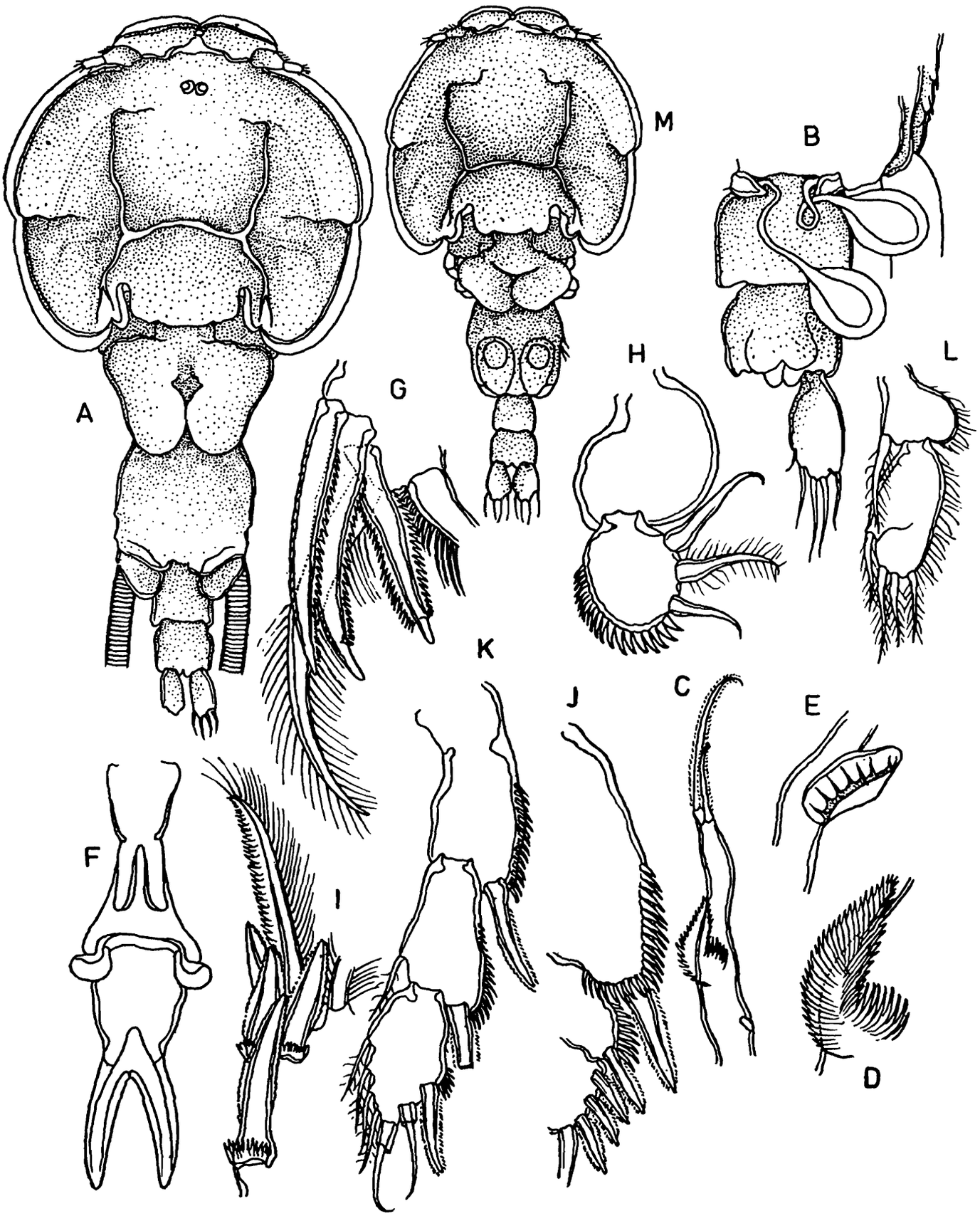


Fig. 166. *Elytrophora hemiptera* Wilson : A-L, Female. A, female, dorsal view ; B, hind end of body, ventral view ; C, maxilla ; D, same, membranous flange ; E, same, knob on distal segment ; F, sternal fork ; G, leg 1, exopod ; H, same, endopod ; I, leg 2, exopod ; J, leg 3, exopod ; K, leg 4, exopod ; L, same, endopod. M, Male, dorsal view.

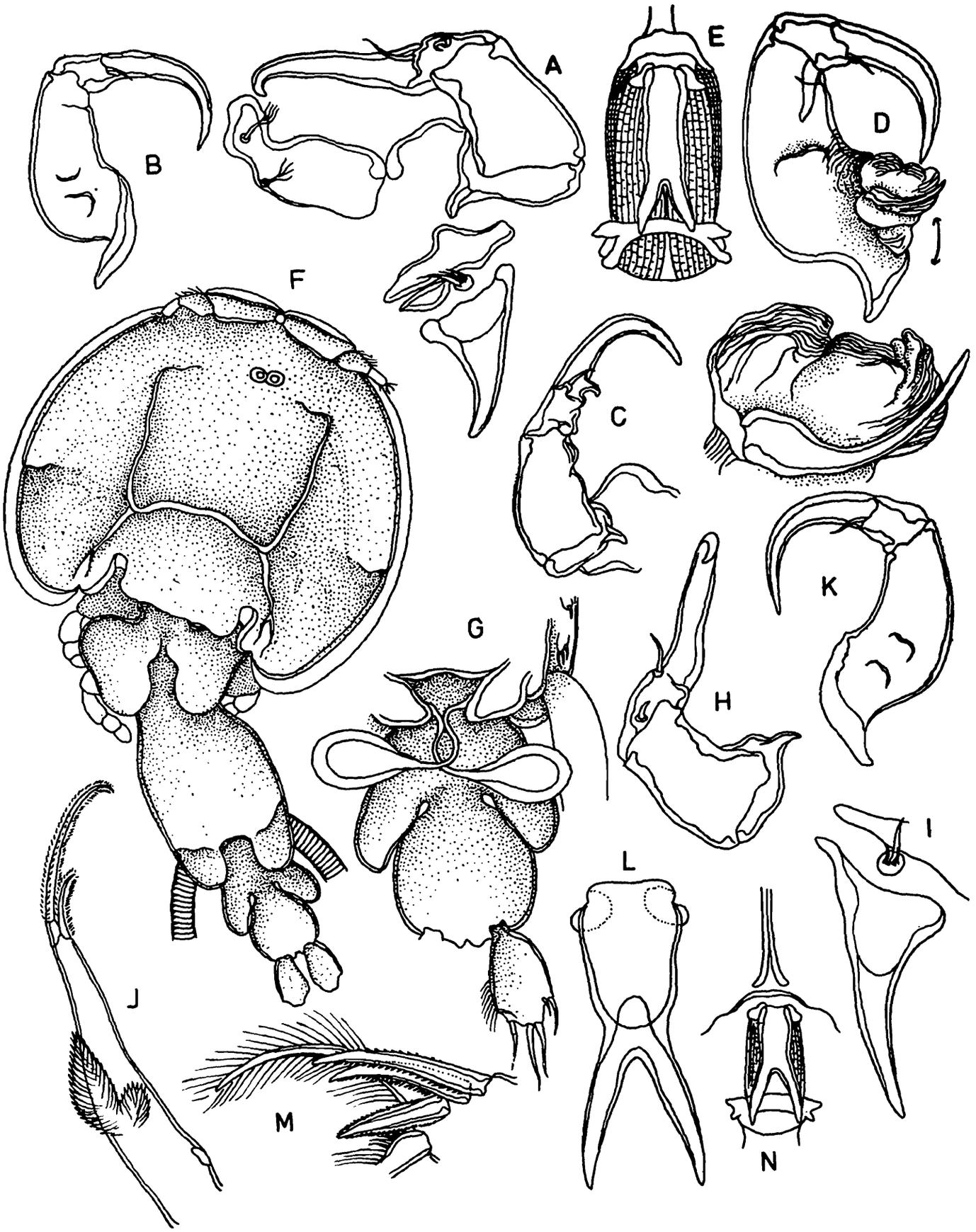


Fig. 167. *Elytrophora hemiptera* (contd.) : A, C-E, Male ; B, Female. A, antenna post-antennal process, post-oral process and maxillule ; B, maxilliped (female) ; C, antenna ; D, maxilliped ; E, sternal fork. F-N, *Elytrophora indica* Shiino : F, female, dorsal view ; G, hind end of body, ventral view ; H, antenna ; I, post-oral process and maxillule ; J, maxilla ; K, maxilliped ; L, sternal fork ; M, leg 1 ; N, sternal fork.

curving inwards and clearly overreaching median lobe. Dorsal plates of fourth thoracic segment posteriorly rounded and touching or even slightly overlapping, laterally with slight median constriction, clearly overlapping genital segment. Genital segment slightly longer than broad, with a pair of large lobes overlapping the egg tubes and directed slightly inwards and overlapping basal segment of abdomen. Basal segment of abdomen longer than distal, posterolaterally angular but not lobed, distal segment nearly rounded or squarish.

Basal segment of antenna with a short, slightly curved process, distal segment long and apically curved, basal part with a small spine and a long spine. Post-antennal process represented by a chitinised plate carrying two bunches of hairs. Post-oral process elongate-triangular and strongly curved. One of the setae of maxillule stout. Distal segment of maxilla with an inner chitinised tubercle, a membranous bilobed flange with prominently serrate borders, distal claw twice as long as the subapical. Maxilliped rather slender, basal segment with two low elevations, distal segment falcate. Sternal fork with base as long as the limbs, latter diverging, apically blunt and incurved.

Distal exopod segment of first leg with three stout prominently serrate claws, ventral serrations end subapically in a large tooth. Spine-like seta very long, twice as long as the second claw and bilaterally plumose, lower setae large. Basal segment of endopod broad, distal with three comparatively short setae and a row of stout sharp teeth. First claw on exopod of second leg large, with narrow serrate wings, second and third subsimilar, with broad serrate wings, first modified seta stout, with serrate ventral flange, second long, with upper serrate flange and ventrally plumose. Basal segment of exopod of third leg with an outer distal crest of sharp teeth, claw straight, with broad serrate wing, second segment with a short row of spines and a winged claw, third segment with three subsimilar claws. Exopod of fourth leg rather slender and elongated, with outer rows of spines, successively decreasing in length from segment one to three, claws long, with fairly broad wings. Endopod of fourth leg indistinctly three-jointed, basal segment bulged on the outer side.

*Length.*—8.3 mm.

*Male.*—Cephalothorax less circular than in female, postero-lateral lobes not curving inwards. Dorsal plates of fourth segment slanting inwards prominently. Genital segment widening towards the middle and further on slightly narrowing. Abdominal segments subsimilar in length and shape.

Antenna more slender, second segment with a grooved inner lobe, third segment more strongly curved, with two spines and an accessory claw. Basal segment of maxilliped with large inner proximal lobe with complicated sculpturing as illustrated. Sternal fork comparatively slender, with very long base and short diverging limbs.

*Length.*—6.0 mm.

*Host.—Thunnus orientalis, Neothunnus albacora, Isurus glaucus.*

*Distribution.*—Cosmopolitan (Indian Ocean, Japan, West Africa and the Mediterranean).

**Elytrophora indica** Shiino
(Figs. 167 F-N, 168)

*Elytrophora indica* Shiino, 1958b, p. 107, figs. 4-6 ; 1959c, p. 351.

*Female.*—Cephalothorax comparatively very large, broader than long, with very slight lateral incision. Frontal plates very low. Postero-lateral lobes reaching far beyond median lobe. Dorsal plates of fourth segment like those of *E. hemiptera* but distally remaining wide apart. Genital segment more slender than in *E. hemiptera*, posterior lobes less prominent. First segment of abdomen as long as second, postero-laterally prolonged into large apically rounded lobes reaching the middle of the second segment, latter remotely circular. Caudal rami rather broad.

Antenna like that of *E. hemiptera.* Post-oral process much longer and narrower than in *E. hemiptera* and less curved. One of the setae of maxillule large, others very small. Distal segment of maxilla distally stouter and less curved, claws more robust. Basal segment of maxilliped with a row of teeth on inner basal part ending in a conical projection, claw stouter than in *E. hemiptera.* Base of sternal fork shorter than limbs, latter more diverging.

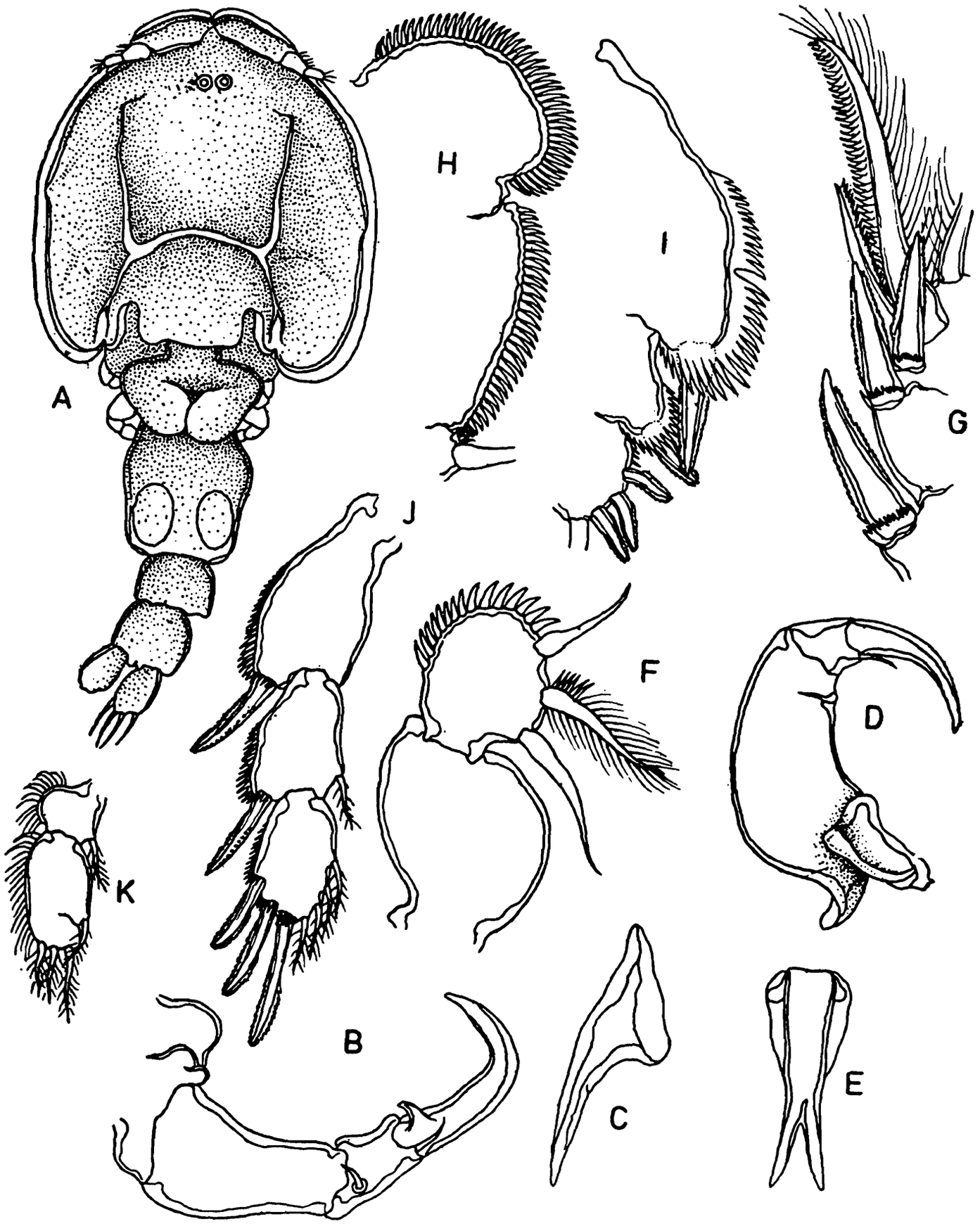


Fig. 168. *Elytrophora indica* (contd.) : A-E, Male. A, male, dorsal view ; B, antenna ; C, post-oral process ; D, maxilliped ; E, sternal fork ; F-K, Female. F, leg 1 ; endopod; G, leg 2, exopod ; H, same, endopod ; I, leg 3, exopod ; J, leg 4, exopod ; K, same, endopod.

Distal segment of exopod of first leg similar to that of *E. hemiptera* but the claws more slender, spine-like seta shorter and more heavily plumose. Distal segment of endopod with stouter setae and fewer teeth. Exopod of second leg similar to that of *E. hemiptera* but the spines forming the wings of the claws and the modified setae coarser. The spines forming the crest on the basal exopod segment of third leg longer and basally fused, the crest on second segment semicircular, claws smaller and weakly spiny and not exactly winged. All the three segments of the exopod of fourth leg with a long row of rather short spines, claws long and slender, endopod with slightly different basal segment.

*Length.*—8.4 mm.

*Male.*—Cephalothorax gradually broadening backwards, postero-lateral lobes not curving inwards. Dorsal plates of fourth segment distally converging and slightly overlapping. First segment of abdomen postero-laterally angular but not lobed.

Second segment of antenna without corrugated pad, third segment more robust. Post-oral process with a small tubercle. Base of sternal fork slender, twice as long as limbs. Basal lobe of maxilliped not so elaborately sculptured as in *E. hemiptera.*

*Length.*—6.6 mm.

*Host.—Makaira mitsukuri, Parathunnus obesus.*

*Distribution.*—Indian Ocean (Bay of Bengal).

*Remarks.*—According to Shiino *E. indica* differs from all the others in the shape of the abdominal segments, first V-shaped with large lobes and the second hexagonal. It may however be pointed out that the first segment is very much similar to that of *E. brachyptera* Gestaecker as described by Lewis (1967). Lewis has pointed out the degree of variation that occurs during the growth of the female, especially in the size of the lobes of the abdomen. A comparative study of material may reduce the number of species. However Heegaard's action in relegating all the species to the synonymy of *E. brachyptera* appears to be a very drastic step. My

study has shown that *E. hemiptera* differs in several characters from *E. indica.* Whether *E. indica* is a synonym of *E. brachyptera* is to be seriously considered. I leave this question open. In the single female of *E. hemiptera* examined two distal claws of the third segment of the exopod of the fourth leg were broken. The regenerated structures are naked feeble setae. It is doubtful whether they would develop into spines. Regeneration among copepods has not so far been studied in any detail.

## Genus **Alebion** Kroyer

*Alebion* Kroyer, 1863, p. 165 ; Wilson, 1907a, p. 702; 1932, p. 418 ; Yamaguti, 1963, p. 99 ; Cressey, 1972, p. 1.

*Diagnosis.*—Cephalothorax large. Frontal plates low, with narrow flange, lunules absent. Fourth thoracic segment small, with a pair of dorsal plates, fused together or separate. Genital segment enlarged and strongly spiny, laterally bulged or not, posteriorly prolonged into a pair of chitinised spiny processes. Abdomen short, two-jointed, first segment with or without lobes. Caudal rami oblong or rectangular, longer than broad.

Antenna prehensile, often with adhesion pads. Post-antennal and post-oral processes modified into adhesion pads. Maxillule typically caligid. Outer flange of distal segment of maxilla converted into a row of spines, claws slender. Maxilliped simple, basal segment often with pad (pads). Sternal fork absent.

First leg biramous, endopod small, two-jointed, distal segment of exopod with the middle claw modified into a pad, other claws blunt, spine-like seta short, a real spine. Rami of second leg three-jointed, second and third claws of exopod pad-like. Apron of third leg often with large spines, rami three-jointed, second segment of exopod with one and third with two pads. Fourth leg an indistinctly two-jointed stump with three to four setae.

Cephalothorax of male similar to that of female. Fourth segment with or without very small lateral lobes. Genital segment narrow, without processes. Abdomen slender, without lobes. Antenna with accessory claw and adhesion pads. Maxilliped with additional armature. Exopod of second leg with first two claws modified.

Parasites of elasmobranchs.

Type species : *A. carchariae* Kroyer.

*Discussion.*—While revising this genus Cressey (1972) recognised only eight out of the fourteen species so far described under this genus as valid. Four, probably five, species occur in Indian waters.

*Key to species of* **Alebion**

| | | |
|---|---|---|
| 1. | Genital segment with prominent lateral bulge | .2 |
| — | Genital segment without prominent lateral bulge | *elegans* Capart |
| 2. | Claw of maxilliped with accessory process. | *crassus* Wilson |
| — | Claw of maxilliped without accessory process | .3 |
| 3. | Lateral bulge of genital segment large, lobes on basal segment of abdomen very small | *maculatus* Wilson |
| — | Lateral bulge of genital segment of moderate size .. | .4 |
| 4. | Processes on first segment of abdomen directed outwards | *gracilis* Wilson |
| — | Processes on first segment of abdomen directed backwards | *carchariae* Kroyer |

## **Alebion maculatus** Wilson
(Figs. 169, 170, 173 K-N)

*Alebion maculatus* Wilson, 1932, p. 423 ; Cressey, 1972, p. 41, figs. 29-43.
*Alebion carchariae* Bassett-Smith, 1898c, p. 366, (nec Kroyer, 1863).
*Alebion alatus* Gnanamuthu, 1951c, p. 1237, figs ; Cressey, 1967b, p. 5.
*Alebion spinosus* Rangnekar, 1959, p. 53, figs.
*Alebion megacephalus* Kirtisinghe, 1956, p. 15, figs.

*Female.*—Cephalothorax gradually widening backwards, frontal plates slightly slanting making the antero-median part angular. Postero-median lobe projecting far beyond lateral lobes, with four pairs of posterior submarginal spines. Dorsal plates of fourth thoracic segment partially fused, bulging outwards, distally narrowed and rounded. Genital segment nearly twice as broad as long, with prominent lateral bulge, lateral borders up to the end of the bulge spiny. Processes of genital segment slender, longer than the segment proper, with a basal transverse row of large spines and a

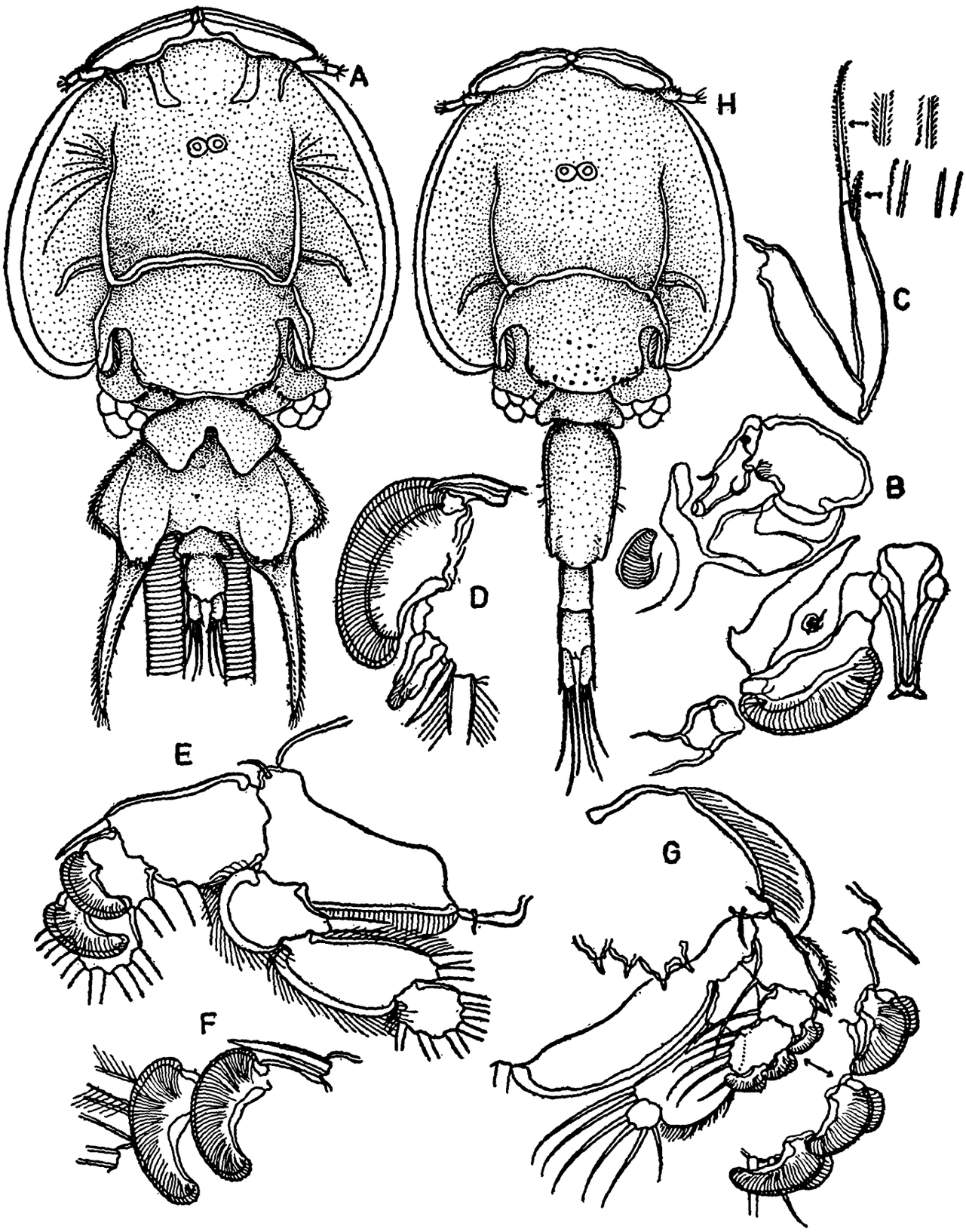


Fig. 169. *Alebion maculatus* Wilson : A-G, Female. A, female, dorsal view ; B, antenna, post-antennal pad, post-oral pad ; C, maxilla ; D, leg 1, tip of exopod ; E, leg 2 ; F, same, tip of exopod; G, leg 3. H, Male, dorsal view.

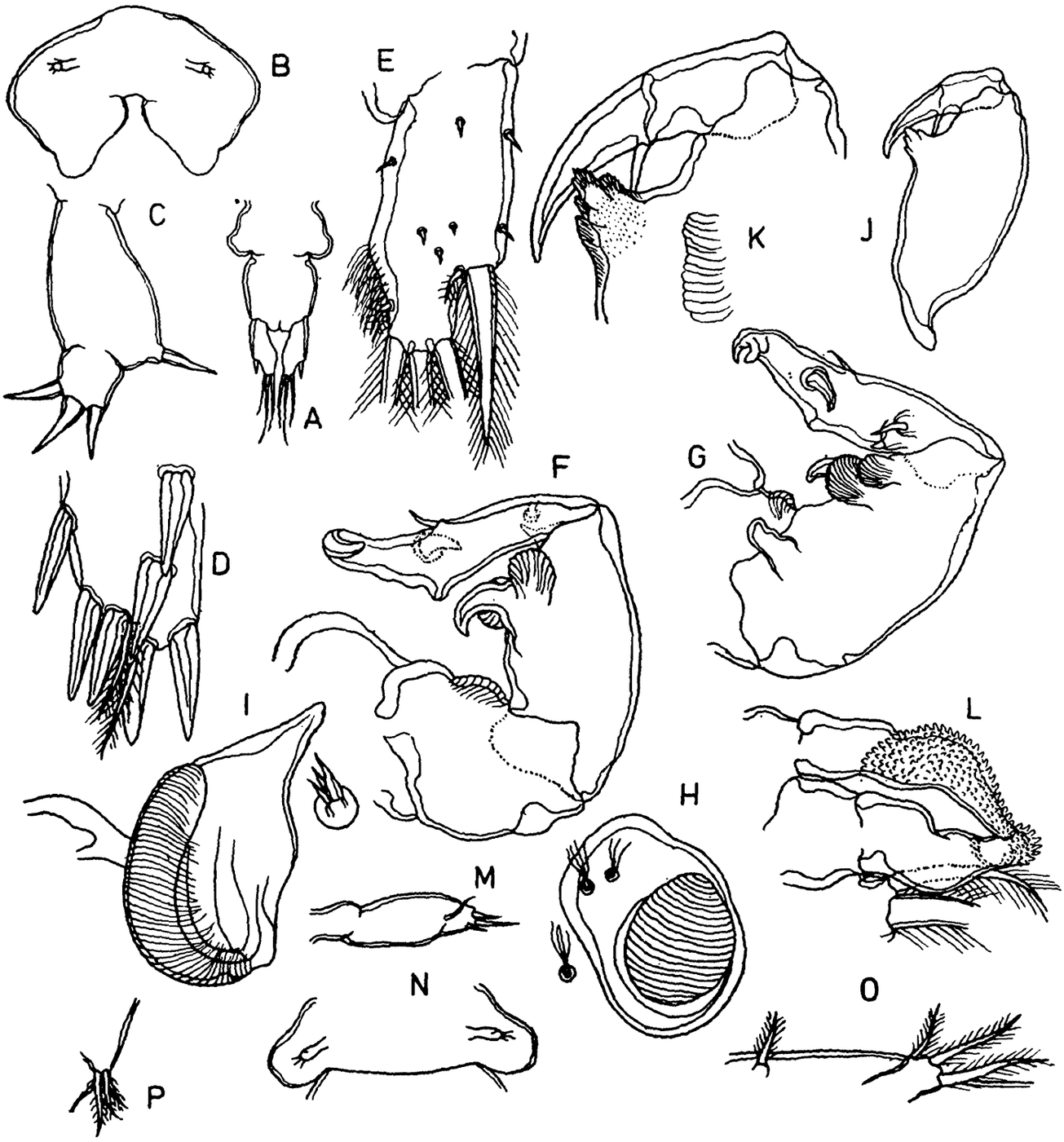


Fig. 170. *Alebion maculatus* (contd.) : A-E, Female. A, hind end of body ; B, leg 4 and dorsal plates ; C, leg 4, enlarged; D, tip of genital process ; E, caudal ramus. F-P, Male : F, antenna, outer view ; G, same, inner view ; H, post-antennal pad ; I, post-oral pad ; J, maxilliped ; K, same, tip enlarged ; L, leg 3, exopod ; M, leg 4 ; N, fourth segment and leg 4 ; O, leg 5 ; P, leg 6.

dorsal and outer longitudinal rows of small spinules. Processes overreaching the setae of the caudal rami. Basal segment of abdomen shorter than distal, with small lobes. Caudal rami with one outer distal plumose spine beyond which the lamina is suddenly narrowed.

Antennule short but stout, with small sparsely pectinate setae. Second segment of antenna with bilobed inner distal adhesion pad, distal segment apically recurved, with one long and one short spine. Post-antennal process a small and post-oral a large adhesion pad. Maxillule with very small setae. Inner claw of maxilla very small, outer long, both with spiny wings. Basal segment of maxilliped with one outer and two inner corrugated pads, base of distal segment enlarged, with a rounded bulge, claw with a small spine.

First claw of distal segment of exopod of first leg small, slightly curved, second a stout corrugated pad, third stout, irregular and apically rounded, spine-like seta slender. Spine on basal segment of exopod of second leg slender and apically acute, pads on second and third segments reaching ventral border of the segments, endopod rather slender, outer border of segments hairy. Apron of third leg with four fairly large spines mounted on projecting base, basal segment of exopod with a sharp spine, pads with high proximal basal outer bulge, second segment of endopod expanded, third very small, velum nearly covering the exopod. Fourth leg indistinctly two-jointed, basal segment with one and distal with three spines.

*Length.*—4.7 mm.

*Male.*—Cephalothorax longer but narrower than in female, median lobe with four pairs of smaller spines. Fourth segment with a pair of small postero-lateral lobes or wings rather than dorsal plates. Genital segment roughly oblong, nearly twice as long as broad and slightly narrowing backwards. Abdomen slender, segments subequal in length. Caudal rami as long as second abdominal segment, with long slender setae.

Basal segment of antenna with one outer pad, second segment with two nearly circular outer pads flanging a large curved claw,

third segment with basal and median spines, outer blunt process and inner curved claw, apex recurved. Post-antennal pad stouter, post-oral prolonged on the inner side. One of the setae of maxillule stout. Basal segment of maxilliped produced at the inner distal part into a sculptured conical lobe, distal segment strong, with a stout spine. Second and third claws on exopod of second leg modified. Fourth leg with four small setae. Fifth leg composed of two parts, an anterior seta and posterior lobe carrying three setae. Sixth leg composed of three setae.

*Length.*—3.6 mm.

*Host.—Carcharias limbatus.*

*Distribution.*—Indian Ocean (Sri Lanka, Bombay, Madras, Madagascar).

*Remarks.*—This species has been well described by Cressey but some minor differences observed should be pointed out. The dorsal plates have an outer declivity and the apex is more rounded. The lobes of the basal segment of the abdomen are larger. The adhesion pad on the second segment of the antenna is double. Basal part of the claw of the maxilliped is more swollen. Third claw of the distal exopod segment of the first leg is irregular. Second segment of the antenna of the male has a stout curved claw between the pads.

### **Alebion crassus** Wilson
(Figs. 171, 172B, 173A)

*Alebion crassus* Wilson, 1932, p. 423, pl. 26 ; Yamaguti, 1963, p. 99 ; Shiino, 1965b, p. 426 ; Cressey, 1972, p. 5, figs. 44-57.
*Platyporinus alatus* Rao, 1950, p. 306.
*Alebion echinatus* Capart, 1953, p. 655 ; Shiino, 1955c, p. 177, figs. 1-3 ; Vaissiere, 1959, p. 544, fig. 5 ; Yamaguti, 1963, p. 100 ; Lewis, 1966b, p. 130, figs. 33-35.

*Female.*—Cephalothorax nearly circular, with large somewhat projecting frontal plates, lateral borders with four pairs of constrictions. Postero-median lobe slightly broader than lateral lobes, not reaching beyond the latter, postero-laterally rounded and

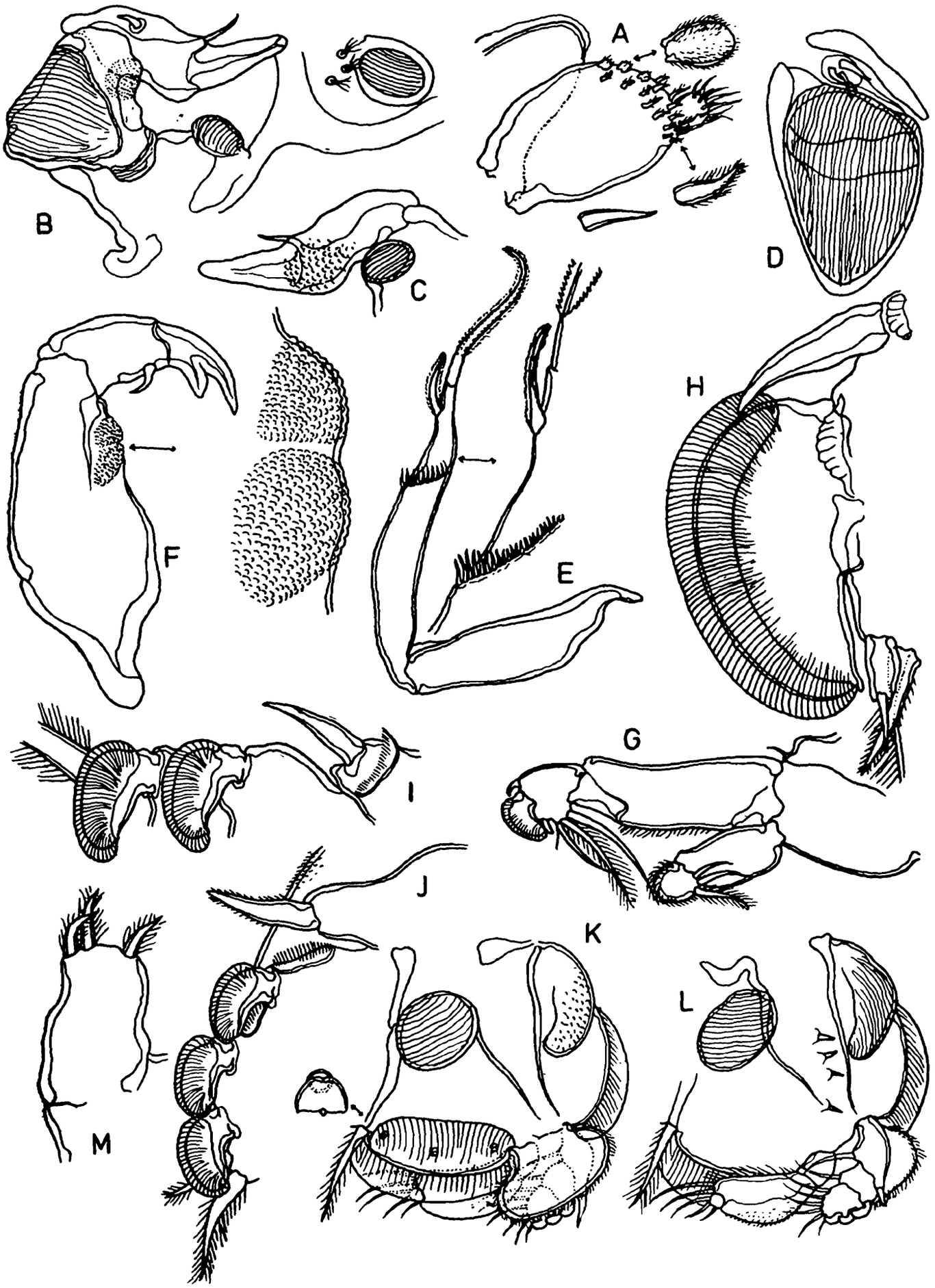


Fig. 171. *Alebion crassus* Wilson : A, antennule ; B, antenna and post-antennal pad ; C, tip of antenna ; D, post-oral pad ; E, maxilla ; F, maxilliped ; G, leg 1 ; H, same, tip of exopod ; I, leg 2, exopod ; J, leg 3, exopod ; K, leg 3, outer view ; L, same, inner view ; M, leg 4.

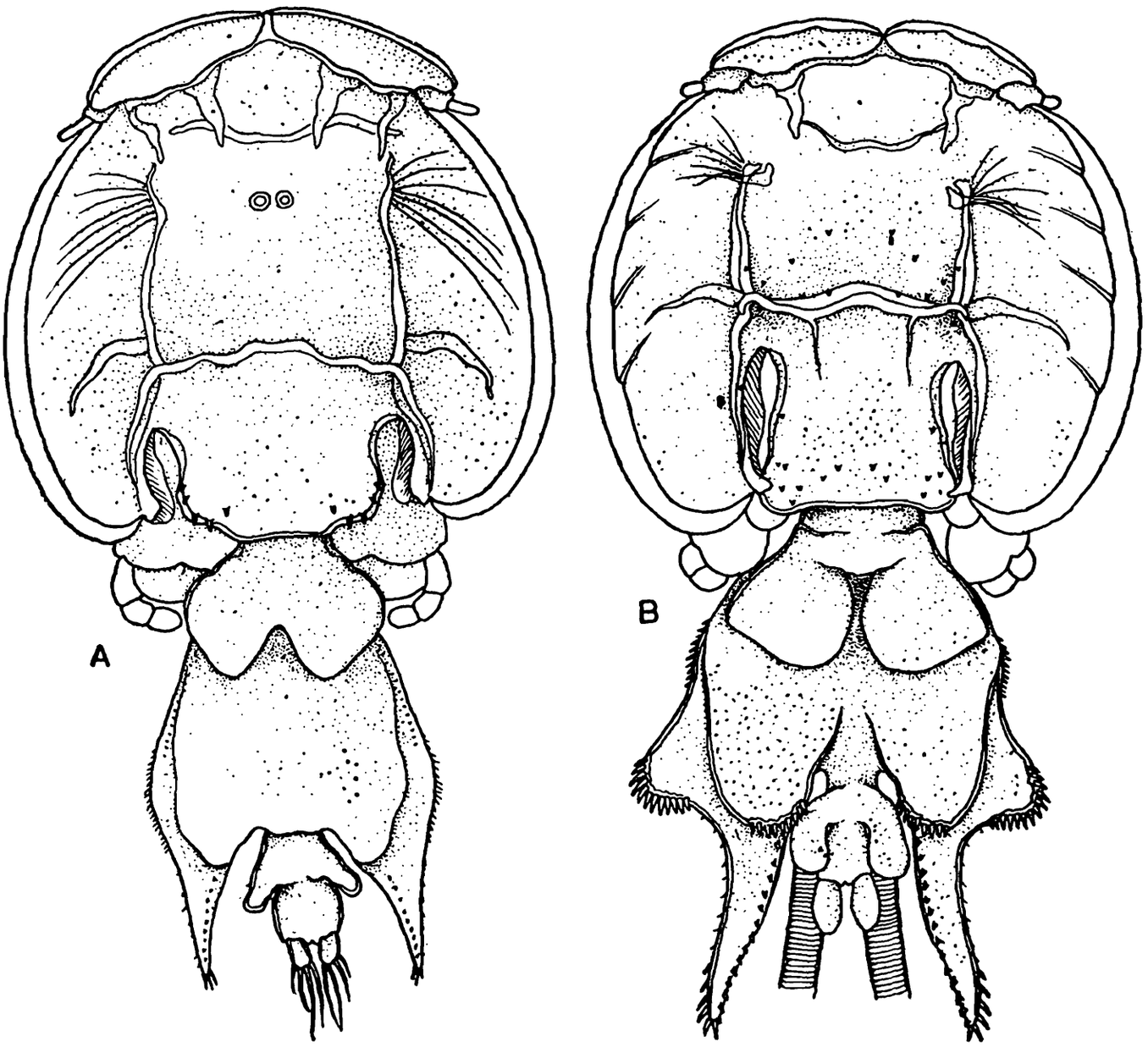


Fig. 172. A, *Alebion gracilis*, female, dorsal view. B, *Alebion crassus*, female, dorsal view.

dorsally with a few spines. A few small spines present just in front of the transverse rib. Fourth segment partly exposed, with the dorsal plates produced outwards and distally rounded, plates not fused together. Genital segment as long as broad, with prominent triangular postero-lateral lobes with marginal and submarginal large spines, a few spines just in front of the beginning of the lobes. Posterior processess of the genital segment double curved, with dorsal and ventral rows of spines, its base with ventral transverse patch of denticles. Genital segment swollen at the base of the

processes into rounded lobes carrying stout spines. Basal segment of abdomen produced into large distally expanded and rounded lobes nearly reaching the distal border of the second segment and overlapping the latter, distal segment expanded sideways.

Basal segment of antennule highly expanded, with different types of setae, distal segment short. Basal segment of antenna with a small pad, second with a large and a small pad, base of third segment stout, distal part short. Post-antennal pad small, post-oral large and longitudinally elongated. Maxillule with one slender and two stout setae. Distal segment of maxilla distally curved, flange in the shape of a transverse row of spines, both claws strongly curved, subapical claw small. Basal segment of maxilliped with large bilobed inner lobe studded with overlapping scales, distal segment with a stout blunt accessory process.

Distal segment of exopod of first leg with the first claw stout and slightly curved, third claw with stout base and sharp distal spine implanted in a sinus, spine-like seta pectinate, distal segment of endopod prominently hairy. First claw of exopod of second leg curved and acute. Apron of third leg with an outer and inner pad and a longitudinal row of four spines, spine on basal segment of exopod curved basalwards and spinulose, third segment of endopod very small, velum transversely oblong. Fourth leg somewhat rectangular, with three plumose setae.

*Length.*—15.2 mm.

*Male.*—Cephalothorax nearly circular, fourth segment as in *A. maculatus*, genital segment much longer than broad, narrowing, second segment of abdomen conspicuously broadening. Distal segment of antenna with a median pad. Distal segment of maxilliped without spines, accessory process stouter. Second modified claw of second leg stout and tubercular, third slender and unarmed.

*Length.*—9.75 mm.

*Host.*—*Sphyrna diplana, S. lewini, S. zygaena, Galeocerdo cuvieri.*

*Distribution.*—Cosmopolitan (Gulf of Senegal, Japan, Hawaii, Bay of Bengal).

*Remarks.*—The large conspicuously spiny lobes and processes of the genital segment, the large lobes of the first abdominal segment, the stout accessory claw of the maxilliped and the longitudinally elongated post-oral pad distinguish this species.

Compared to the illustrations provided by Cressey the present specimen shows slight difference in the shape of the abdominal lobes and the shape of the third claw of the distal exopod segment of the first leg.

**Alebion gracilis** Wilson
(Fig. 172A, 173 B-J)

*Alebion gracilis* Wilson, 1905b, p. 128 ; 1907a, p. 704, pl. 18, figs. 35-48 ; 1932, p. 420, fig. 264 ; Vaissiere, 1959 ; p. 549 Shiino, 1959d, p. 316, figs. 19-21 ; Yamaguti, 1963, p. 100 ; Cressey, 1970, p. 5 ; 1972, p. 7, figs. 88-99.

*Female.*—Cephalothorax gracefully rounded, lateral borders even. Postero-median lobe one and a half times as broad as lateral lobes and slightly projecting beyond them, with five pairs of submarginal spines forming two arcs. Frontal plates large and projecting. Dorsal plates of fourth segment partially fused, distally broadly rounded. Genital segment as long as broad, with slight lateral bulge and a short row of submarginal dorsal spines. Lateral borders including that of the posterior processes sparsely spiny throughout. Posterior processes comparatively short, with dorsal and lateral spines. Basal segment of abdomen produced into narrow postero-lateral lobes, distal segment nearly rounded.

Second segment of antenna rather stout, with one outer pad, distal segment with a proximal inner process and median inner spine, there is also a grooved lobe, apex of the segment blunt and grooved, with an apical small lobe. Post-oral pad large, conically produced inwards. Distal segment of maxilla distally not curved, membranous flange not spiny but hairy, apical claws nearly straight, with broad wings. Basal segment of maxilliped with a bilobed pad, distal segment very stout, with a long spine, beyond the spine the lower portion expanded into a corrugated flange.

First and third claws of distal exopod segment of first leg stout and smooth, spine longer than third claw and pectinate. First claw

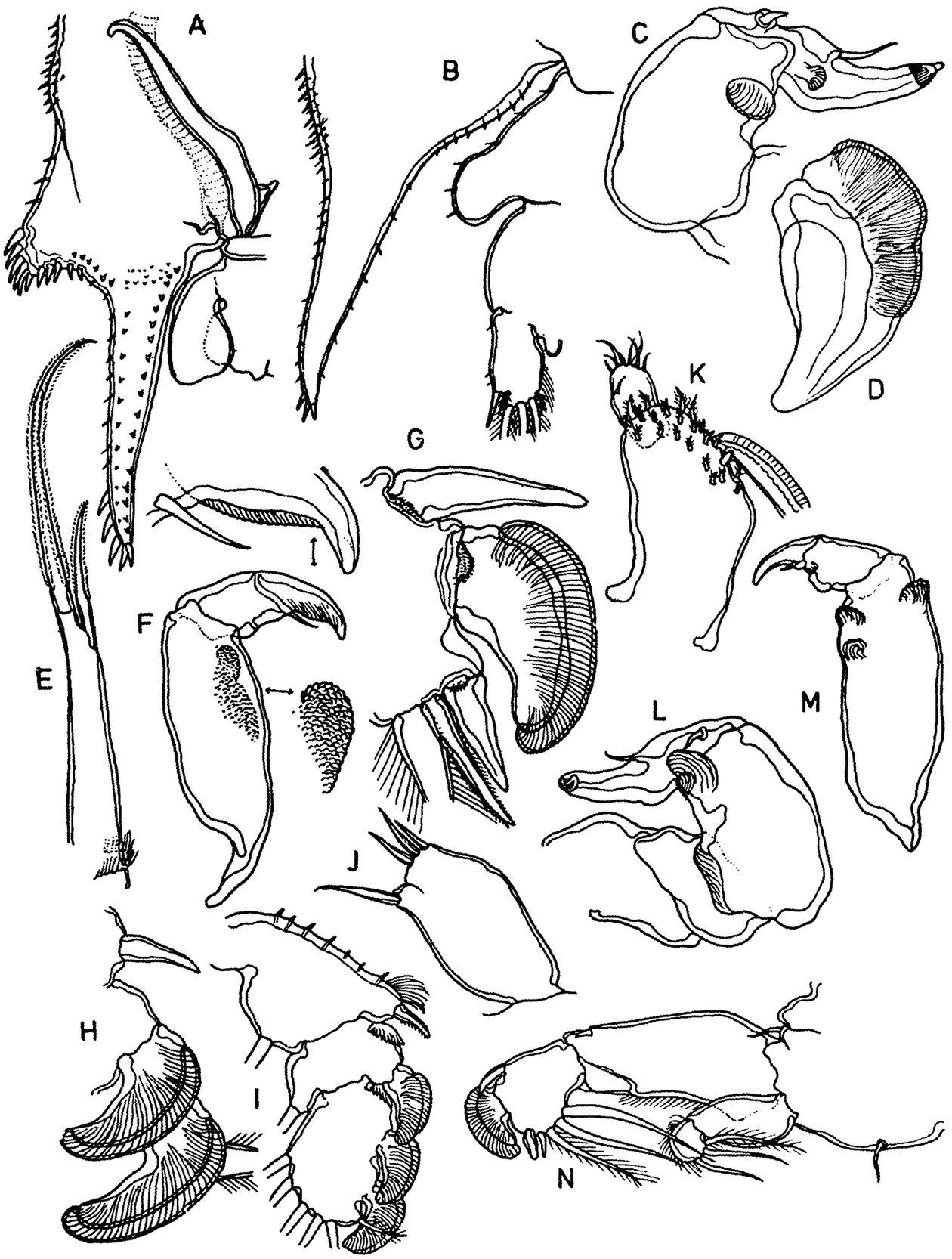


Fig. 173. A, *Alebion crassus*, hind part of body, ventral view. B-J, *Alebion gracilis*: B, hind part of body, ventral view ; C, antenna ; D, post-oral pad ; E, maxilla ; F, maxilliped ; G, leg 1 ; H, leg 2, exopod ; I, leg 3, exopod ; J, leg 4. K-N. *Alebion maculatus*, female (contd.) : K, antennule ; L, antenna ; M, maxilliped ; N, leg 1.

of exopod of second leg short and sharp. Outer border of first segment of exopod of third leg with a row of spines, spine bilaterally pectinate. Second and third segments with a proximal outer spiny crest. Fourth leg oblong, with a long subapical and three shorter apical spines.

*Length.*—1.8 mm.

*Male.*—Cephalothorax slightly broader than long, median lobe projecting, fourth segment with only indications of dorsal plates. Genital segment narrowing backwards, abdomen slender, shorter than genital segment.

First and second segments of antenna with adhesion pad, third with an accessory process. Second claw of exopod of second leg stout, almost fully pustulose, third similar to second but more slender.

*Length.*—5.7 mm.

*Host.*—*Mustelus canis, Carcharias taurus, Carcharhinus obscurus, C. platyrhynchus, C. lamiella, Squalus acanthias, Pollachius virens.*

*Distribution.*—According to Cressey confined to the east coast of the United States of America.

*Remarks.*—*A. gracilis* closely resembles *A. carchariae* and according to Cressey many of its records should be assigned to the latter species. Cressey's earlier record from the Indian ocean was later corrected as *A. carchariae.* But he himself accepted Vaissier's record of *A. gracilis* from East Africa. Hence this species is provisionally included in the Indian fauna.

### **Alebion carchariae** Kroyer

*Alebion carchariae* Kroyer, 1863, p. 165, p. 12 ; Cressey, 1972, p. 3, figs. 1-28.
*Alebion fuscus* Wilson, 1921, p. 2.
*Alebion difficilis* Yamaguti, 1963, p. 100.
*Alebion gracilis* Lewis, 1966b, p. 136, figs. 36-38 ; Cressey, 1967b, p. 5.

*Female.*—Cephalothorax broadening backwards, frontal plates projecting, postero-median lobe only slightly broader than lateral lobes. Dorsal plates of fourth segment fused, posteriorly angular. Genital segment only slightly broader than long, proximal part of its borders spiny, median bulge of moderate size, with a row of spines. Posterior processes comparatively short, overreaching the setae of the caudal rami. Abdomen indistinctly segmented, basal segment produced into long lobes just reaching the tip of the second segment, latter with slightly convex sides.

Second segment of antenna with a small adhesion pad, third stout, with a short and a long spine. Basal segment of maxilliped rather small, with a small patch of scales, distal segment stout, its basal half broad. First and third claws on distal segment of exopod of first leg stout, blunt and subsimilar, spine-like seta slender and hirsute. Basipod of third leg with a row of four spines. first segment of exopod with three to four spines and a serrate crest on outer border, claw prominent, second and third segments with a proximal outer serrate crest, second segment of endopod not expanded. Fourth leg slender, with four pectinate spines, first spine small.

*Length.*—8.0 mm.

*Male.*—Cephalothorax nearly circular, with large, projecting frontal plates. Fourth segment transversely oblong, without plates or lobes. Genital segment narrowing. Second segment of abdomen longer than first. Antenna almost similar to that of *A. maculatus* in armature. Basal segment of maxilliped with a high projecting patch of scale-like processes. Claws on exopod of second leg modified, nearly straight and pustulose. Ventro-lateral parts of genital segment spiny.

*Length.*—6.0 mm.

*Host.*—Various species of sharks.

*Distribution.*—Cosmopolitan.

*Remarks.*—According to Cressey this species closely resembles *A. gracilis* Wilson and several records of the latter should be

assigned to *A. carchariae*. The abdomen of the two species is different in shape and the spermatophores which according to Cressey show specific difference, are totally different. There are recognisable differences in the armature of the third and fourth legs. The above description is from Cressey (1972).

## **Alebion elegans** Capart

*Alebion elegans* Capart, 1953, p. 656 ; Cressey, 1967b, p. 5 ; 1972, p. 6, figs. 58-73.

*Female.*—Cephalothorax broadening backwards, frontal plates large and projecting, postero-median lobe as broad as lateral lobes and projecting. Fourth segment partially exposed, dorsal plates fused together, posteriorly acute. Genital segment longer than broad, slightly bulged laterally, no distinct lobe at all. Posterior processes narrowing, with a dorsal and a ventral row of spines. Basal segment of abdomen laterally produced into prominent lobes not reaching the tip of the distal segment, latter regularly widening.

Antenna and maxilliped without special armature. First and third claws of distal segment of exopod of first leg blunt, first longer, spine-like seta very small and plumose. Legs two to four as in *A. carchariae*.

*Length.*—10.0 mm.

*Male.*—Cephalothorax comparatively very large, broadest in the middle, fourth segment with small conical dorsal plates directed outwards, genital segment small, elliptic, abdomen slender, as long as genital segment.

First and second segments of antenna with large adhesion pad, third segment apically acute, with two spines and an accessory claw. Basal segment of maxilliped with a highly projecting large double boss with scaly surface, distal segment long. First claw of exopod of second leg slender, second stout, its distal half pustulose, third reaching far beyond the third segment, its distal one third pustulose.

*Length.*—5.5 mm.

*Host.*—*Sphyrna* spp.

*Distribution.*—Atlantic and Indian oceans.

*Remarks.*—Cressey recorded this species from the Indian ocean and the above description is based on his publication (Cressey, 1972). The near absence of lobes on the genital segment of the female and the characters of the male distinguish this species from all the rest recorded from the Indian waters.

Inserte sedis

Genus **Paralebion** Wilson

*Paralebion* Wilson, 1911b, p. 627 ; Yamaguti, 1963, p. 104 ; Cressey, 1970, p. 2.

*Diagnosis.*—Cephalon fused with first three thoracic segments to form a large cephalothorax. Frontal plates ill defined, without lunules. Fourth thoracic segment produced at the base of the legs but without dorsal plates. Genital segment moderately large, postero-laterally produced into lobes or not. Abdomen long or short, one or two-segmented. Caudal rami varying in shape.

Antennule with basal process. Post-antennal and post-oral processes well developed claws. Sternal fork present. Legs basically caligid, first and fourth uniramous, second and third biramous.

Parasites of elasmobranchs and teleosts.

Type species : *P. elongatus* Wilson.

*Discussion.*—The most recent definition of this genus is that by Yamaguti. Though he placed three species, *P. elongatus* Wilson (1911), *P. curticaudus* Wilson (1913) and *P. pearsi* Causey (1953) in this genus his definition of the genus is virtually a repetition of the original definition by Wilson which takes into consideration only the type species. The three known species differ so much from one another that it is doubtful whether they can all be placed in the same genus.

As observed by Cressey *Paralebion* is not at all related to *Alebion* and cannot be retained in Euryphoridae. It must be found a place in Caligidae, obviously in Lepeophtherinae. It is significant that *Lepeophtheirus elongatus* Heegaard (1962) shows great similarity to *Paralebion elongatus* and is probably a synonym of the latter.

**Paralebion elongatus** Wilson
(Fig. 174)

*Paralebion elongatus* Wilson, 1911b, p. 628, pl. 66, figs. 13-21 ; Bere, 1936, p. 593; Yamaguti, 1963, p. 104, pl. 128, fig. 2; Cressey, 1970, p. 2, figs. 5-11.
*Lepeophtheirus elongatus* Heegaard, 1962, p. 168, figs. 116-123.

*Female*.—Cephalothorax large, slightly broader than long, with two pairs of antero-lateral constrictions, membranous flange of moderate width. Frontal plates small, ill-defined, fused with cephalothorax and slanting towards the antero-median part. Postero-median lobe twice as broad as lateral lobes, distally truncate and not reaching the lateral lobes. Posterior sinuses deep and partially closed behind. Fourth segment elongated, produced at the base of the legs, but there is no trace of dorsal plates. Genital segment longer than broad, regularly broadening backwards and postero-laterally produced into long digitiform lobes as long as the segment proper. Abdomen as long as cephalothorax, two-segmented, distal segment very short, basal with indications of a partition. Caudal rami more than twice as long as broad, parallel sided, distal border irregularly transverse, with five short sparsely plumose setae.

Basal segment of antennule flattened, somewhat ovate, with sparsely pectinate setae, distal segment nearly as long as basal. Basal segment of antenna with a long slender process, distal very long and slender, apically bent at right angles. Post-antennal process with short base, claw long and well curved. Post-oral process with short but broad base, claw long, slender and strongly curved. Maxillule with cylindrical base carrying three setae. Distal segment of maxilla with large outer lobe, claws comparatively short, with broad serrate wings. Maxilliped with moderately stout basal segment with an unusually large basal lobe giving attachment to strong muscles, second segment slender and slightly curved, with

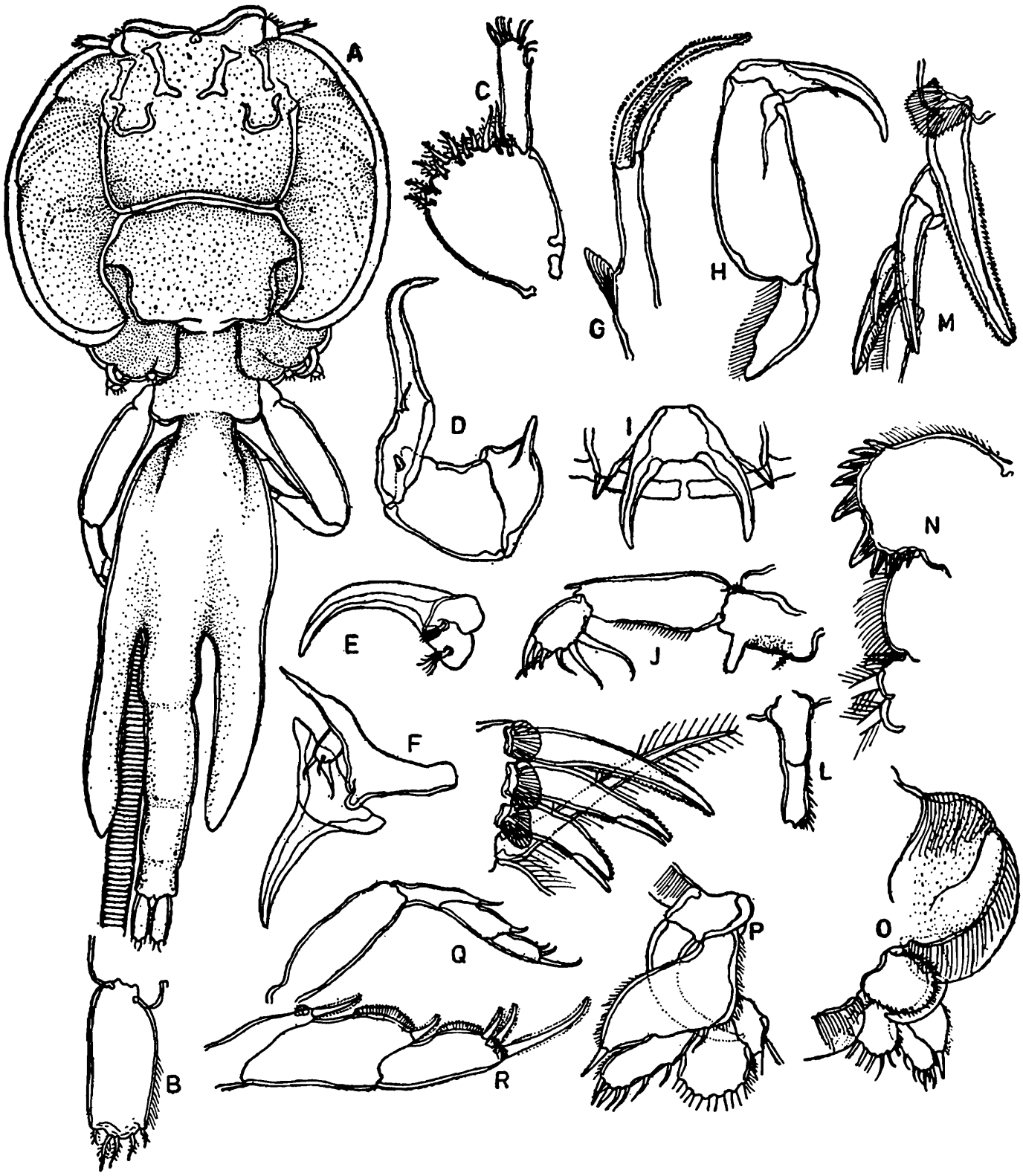


Fig. 174. *Paralebion elongatus* Wilson : A, female, dorsal view ; B, caudal ramus ; C, antennule ; D, antenna ; E, post-antennal process ; F, post-oral process and maxillule ; G, maxilla ; H, maxilliped ; I, sternal fork ; J, leg 1 ; K, same, tip of exopod ; L, same, vestigial endopod ; M, leg 2, exopod ; N, same, endopod ; O, leg 3 ; P, same, rami, inner view ; Q, leg 4 ; R, same, tip enlarged.

one spine. Sternal fork with very short base and long slender diverging limbs apically curved inwards, a chitinous spine-like process on either side of the sternal fork.

Basipod of first leg with a patch of spinules, endopod cylindrical, its inner and distal margins spiny, first segment of exopod with ventral row of spines, distal segment with three bluntly toothed claws successively decreasing in length, second and third with large accessory claw, spine-like seta long, sparsely plumose, ventral setae normally developed, each claw with a large basal lobe. Claws on exopod of second leg with strongly serrate flange, successively decreasing in length, first seta with ventral and second with dorsal wing. Basal segment of endopod produced outwards, with an arc of about ten to eleven strong teeth, proximal part of border with stiff hairs, second and third segments hairy. Apron of third leg reduced in size, outer part with large spiny adhesion pad, basal claw of exopod long, slender and sickle-shaped, second segment produced at the outer distal part into a conical lobe so that the third segment lies alongside the second, third segment with small setae. Fourth leg four-jointed, basal segment shorter than rest of limb, second segment proximally narrow, with one claw and a semicircular crest of spines, second with a smaller claw and a long patch of spines, third with three claws, apical claw twice as long as the penultimate, a long and two short patches of spinules. Fifth and sixth legs not observed.

*Length.*—14.0 mm.

*Male.*—Frontal plates smaller than in female. Fourth segment gradually widening backwards, genital segment elliptic, as broad as fourth segment, abdomen two-segmented, second segment longer and broader than first. Second segment of antenna stout, with prominently corrugated surface, third segment short but stout, with small accessory claw.

*Length.*—7.5 mm.

*Host.*—*Scoliodon terrae-novae, Negaprion brevirostris, Carcharias obscurus, C. commersoni, Carcharhinus milberti, C. leucas, C. limbatus.*

*Distribution.*—Chepseake Bay, Galapagos, Gulf of Meixco, Dry Tortugas, Florida, Beaufort, East Africa, Indian ocean.

*Remarks.*—In practically every character this copepod is unusual. Heegaard's description of *L. elongatus* hardly depicts the details but there is no doubt that it is a synonym of *P. elongatus*. The above description of the female is based on a specimen kindly gifted by Cressey and that of the male is after Cressey (1970).

## Family ANTHOSOMATIDAE

*Diagnosis.*—Cephalon fused with first thoracic segment forming a cephalothorax, its lateral parts expanded and folded downwards and often forwards (in *Anthosoma* posteriorly prolonged into an enormous hood covering a large part of the trunk). Thoracic segments two to five partially or completely fused, third segment (except in *Anthosoma* and *Lernanthropodes*) produced backwards as a lobe (dorsal plate) covering the hind part of trunk (second and third segments free in *Anthosoma* and the former with a pair of plates or lamellae). Genital segment distinct. Abdomen one-segmented. Caudal rami large.

Antennule slender and sparsely setose, segmentation usually distinct. Antennae prehensile, fused together (except in *Anthosoma*). Maxillule bilobed. Maxilla two-jointed, with distinct unguis. Maxilliped uncinate or subchelate. Legs one and two small, with one-jointed small rami, third often highly modified, fourth lamellar and fifth usually small or absent (all legs lamellar in *Anthosoma*).

Egg tubes long and trailing behind body or coiled and hidden by the dorsal plate.

Male small, with or without pronounced sexual dimorphism.

Parasites of elasmobranchs and teleosts.

Type genus : *Anthosoma* Leach.

*Discussion.*—It is unfortunate that *Anthosoma* which is totally different from all the other genera of the family became the type genus. The inclusion of *Anthosoma* makes it difficult even to give a precise definition of the family. A convenient proceedure would be to resurrect subfamily Anthosomatinae Dana and place *Anthosoma* under it and create a new subfamily Lernanthropinae to accommodate the rest. This arrangement even if arbitrary will be convenient.

Yamaguti included in this family *Epachthes* Nordmann (1832), *Anthosoma* Leach (1816), *Norion* Nordmann (1864), *Caetrodes* Wilson (1906), *Sagum* Wilson (1913), *Lernanthropus* Blainville (1822), *Pseudolernanthropus* Yamaguti and Yamasu (1960) and *Lernanthropodes* Bere (1936). Yamaguti treated *Aethon* Kroyer as a synonym of *Lernanthropus* but Hewitt (1968b) considered it as valid. Hewitt also created a new genus *Paralernanthropus.* Thus the family contains ten genera.

Pillai (1968c) showed that *Caetrodes* is a synonym of *Hatschekia.* It may be mentioned in this context that Wilson correctly placed this genus in Dichelesthiidae and not Anthosomatidae. Pillai and Sebastian (1967) made *Pseudolernanthropus* a synonym of *Sagum.* Hewitt supported this action but expressed doubt regarding the placement of species under it. *Epachthes* has not been discovered since its creation and Nordmann did not give a figure of the species. The available information is insufficient to permit any comment on its affinity. Assuming that it is valid there are in all eight valid genera in Anthosomatidae.

A detailed study of the material collected from South Indian waters has shown that the taxonomy of this family is rather confusing. The key provided by Yamaguti contains many defects and even the more recent one provided by Hewitt is not satisfactory. But it has to be conceded that both Yamaguti and Hewitt had to depend on published descriptions some of which are unsatisfactory. This is particularly true of *Norion, Aethon* and *Sagum.* The single factor responsible for all this confusion is the peculiar development of the third pair of legs. This leg is variously modified and in many genera is fused with the trunk altering the shape of the latter considerably.

*Key to genera of* ANTHOSOMATIDAE

1. Cephalothorax produced backwards as a large hood, all legs flattened lamellae . **Anthosoma** Leach
— Cephalothorax not produced into a hood, all legs not flattened lamellae .2
2. Third legs fused into a dorsally open tube covering the hind part of body, dorsal plate absent **Lernanthropodes** Bere
— Third legs not fused into a tube, dorsal plate present .3
3. Egg tubes straight, trailing behind the body . **Lernanthropus** Blainville
— Egg tubes coiled and hidden under the dorsal plate .4
4. Rami of fourth legs progressively narrowing, distally not whip-like **Paralernanthropus** Hewitt
— Rami of fourth leg distally suddenly narrowed or whip-like .5
5. Protopods of third legs projecting on either side of trunk as large lobes .6
— Protopods of third legs not projecting on either side of trunk **Sagum** Wilson
6. Anterior division of trunk with segmentation . **Aethon** Kroyer
— Anterior division of trunk without segmentation .**Norion** Nordmann

## Genus **Anthosoma** Leach

*Anthosoma ;* Shiino, 1955a, p. 50 ; Yamaguti, 1963, p. 144 ; Lewis, 1966b, p. 66 ; Hewitt, 1968b, p. 23.

*Diagnosis.*—Cephalothorax posteriorly produced into a large hood covering a large part of the trunk, with pronounced constriction behind the anterior end. Second and third thoracic segments free, fourth partially free and fifth fused with genital segment, second segment with a pair of dorsal lamellae. Genital segment large. Abdomen small, one-jointed. Caudal rami large.

Antennule six-jointed, twisted and poorly armed. Antenna four-jointed, twisted and ending in a strong claw. Maxillule bilobed, each lobe two-jointed. Maxilla two-jointed, distal segment ending in a movably articulated armed spherical unguis. Maxilliped two-jointed and subchelate. Legs one to three lamellar, fourth absent.

Male smaller than female, all thoracic segments free. Apex of antenna with additional armature. Second thoracic segment without elytra. Genital segment small.

Type species : *A. crassum* (Abildgaard).

**Anthosoma crassum** (Abildgaard)
(Fig. 175)

*Caligus crassus* Abildgaard, 1794, p. 46, pl. 5, figs. 1-3.
*Anthosoma crassum* Stp. & Lutk., 1861, p. 397, pl. 12, fig. 24 ; Scott, T & A, 1903, p. 108, pl. 23, figs. 5-6 ; Wilson, 1932, p. 446, fig. 281 ; Yamaguti, 1936b, p. 12 ; Barnard, 1955, p. 271, fig. 18 ; Shiino, 1955a, p. 51, figs. 1-2 ; Lewis, 1966b, p. 66, figs. 4-6 ; Hewitt, 1968b, p. 23, figs. 78-101.

*Host.—Isurus glaucus, I. oxyrhynchus, Carcharias littoralis, Carcharodon carcharias, Carcharhinus obscurus, Lamna cornubica, L. nasus, Cetorhinus maximus, Mustelus mustelus.*

*Distribution.*—Cosmopolitan.

*Remarks.*—This widely distributed species has been described several times. The more recent detailed descriptions are those by Shiino, Lewis and Hewitt. The following discussion is based on a single female gifted by Dr. Roger Cressey.

The antennule as observed by Lewis is six-jointed but the proximal joint has an incomplete partition. The distal segments are distally swollen and the apical segment carries about eleven setae of which two are stout. As my specimen did not have the antennae I am unable to express any definite opinion regarding the number of segments it has. According to Lewis this appendage is four and not five-segmented as observed by Shiino. Lewis suggested that what Shiino considered as the first segment is only a flexible arthrodial membrane. As the antenna of other anthosomatids shows indications of a maximum of four segments it is likely that *Anthosoma* has a four-jointed antenna.

Shiino has given the best illustrations of the maxillae and maxillipeds. The inner part of the second segment of the maxilla is expanded and has a wavy border. It is distally produced into a large

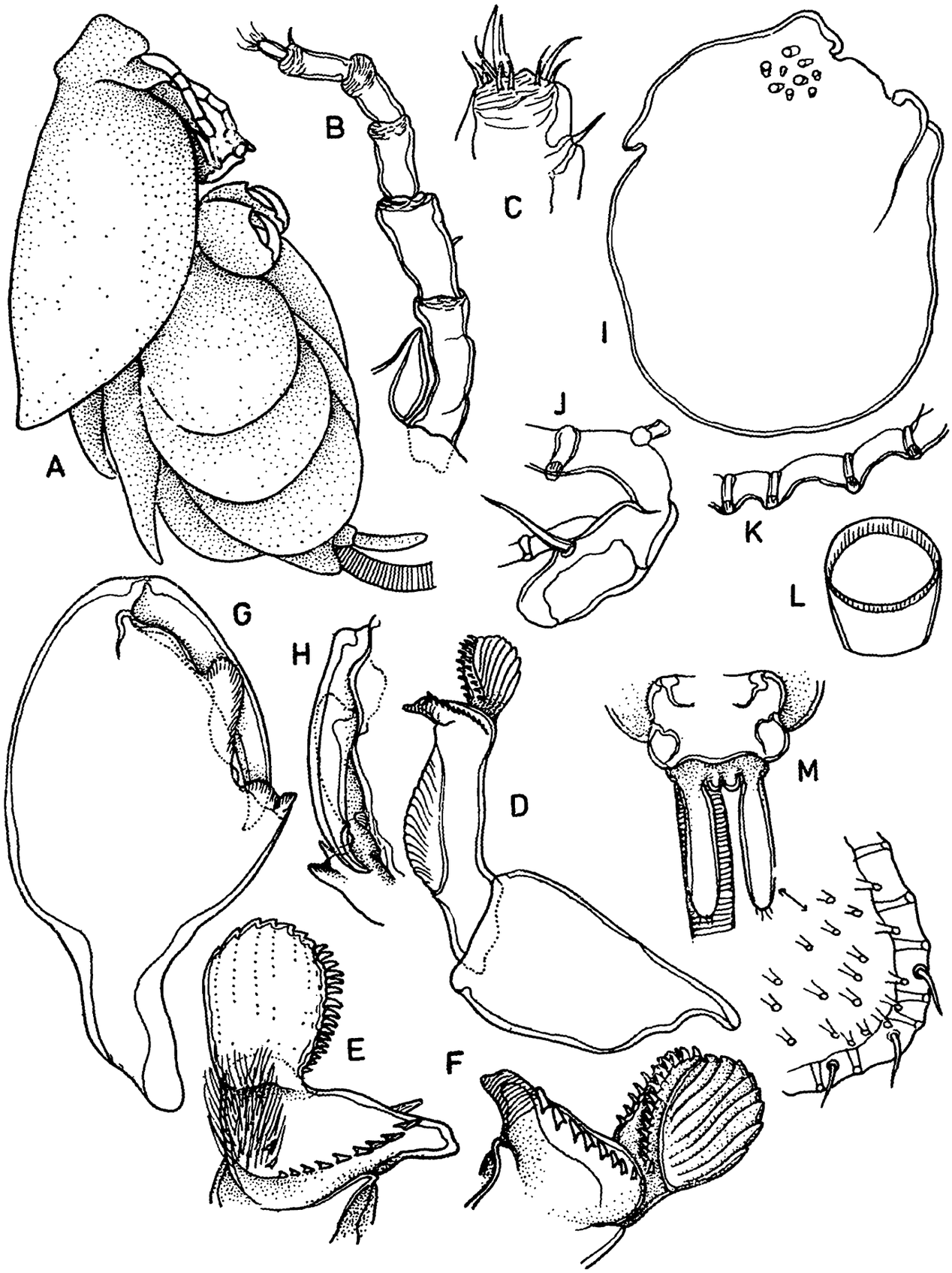


Fig. 175. *Anthosoma crassum* Abildgaard : A, female, lateral view ; B, antennule ; C, same, tip enlarged ; D, maxilla ; E, same, tip, inner view ; F, same, outer view ; G, maxilliped ; H, same, inner view ; I, leg 1 ; J, same, vestigial ramus ; K, same, margin ; L, one of the tubercles ; M, caudal rami.

blunt process carrying a semicircle of strong sharp spines and a patch of stiff hairs. These make the maxilla remotely resemble that of eudactylinids. The apex of the segment which is the counterpart of the unguis of other anthosomatids is converted into a globular structure with grooved surface and an inner semicircle of teeth. The basal segment of the maxilliped has a step-like proximal expansion which is bilobed and carries a strong inner spine. The surface of the lobe is grooved. Beyond the step-like projection there is a concavity and further on the border is raised into a high lobe with grooved surface. The palmar surface is channelled and the inner edge of the channel is raised into three low projections. In Shiino's illustrations the dactyliform second segment is apically truncated and only just reaches the basal process of the proximal segment. But this segment as shown by Lewis is apically acute and reaches far beyond the projection.

The legs have been well described by Lewis but I find that the borders are more strongly spiny and the surface is studded with peculiarly shaped structures, each a hollow cylinder projecting on the surface. On the caudal rami there is a concentration of these. Each caudal ramus carries four apical setae.

## Genus **Lernanthropus** Blainville

*Lernanthropus ;* Tripathi, 1962a, p. 207 ; Yamaguti, 1963, p. 146 ; Pillai, 1963c, p. 655 ; 1964a, p. 46 ; Hewitt, 1968b, p. 8.

*Diagnosis.*—Cephalon fused with first thoracic segment forming a cephalothorax, its lateral parts expanded and folded downwards and often projecting forwards. Antennular lobe usually demarcated. Second and third thoracic segments fused into a forebody (anterior division of trunk) posteriorly prolonged into a large lobe (dorsal plate) overlapping the hind body (posterior division of trunk), posteriorly entire or deeply forked. Hind body composed of fourth, fifth and genital segments and the one-jointed abdomen, segments free or variously fused. Caudal rami large, usually with two proximal and two distal setae.

Antennule sparsely setose, segmentation distinct or not. Antennae strongly prehensile, two-jointed, basally fused. Maxillule bilobed, inner lobe small, outer large, both with apical spines. Maxilla

two-jointed, distal segment distally armed with spines, teeth or tubercles, unguis distinct, toothed. Maxillipeds prehensile, generally smaller than antennae. Legs one and two biramous, with short one-jointed rami armed with spines and teeth. Third legs variously modified, fused together or separate, uniramous or biramous, exopod often fused with trunk and protopod at least in a few species produced forwards. Fourth leg biramous, lamelliform. Fifth leg uniramous, often reduced in size or absent.

Male comparatively small, body segmentation evident. Antennae large. Cephalic and first two thoracic appendages as in female. Third leg usually uniramous and short, endopod indicated by a lobe. Fourth leg longer than third, generally biramous. Fifth leg a setule mounted on a nodule.

Parasites of teleosts.

Type species : *L. musca* Blainville.

*Discussion.*—This genus now contains nearly a hundred species though the identity of many is doubtful. Some of those listed by Yamaguti will certainly have to be transferred to other genera.

In his definition of the genus Yamaguti observed that the second and third thoracic segments are sometimes free and covered with a single dorsal plate extending backwards. The dorsal plate apparently originates from the hind end of the third segment though Hewitt observed that it originates from the fourth segment. This is difficult to decide but the third legs often originate just opposite the base of the dorsal plate and the fourth segment is often visible behind. Hence it would appear that the dorsal plate is an extension of the third segment. Yamaguti described the abdomen as one or two-segmented. But as far as I know anthosomatids have one-segmented abdomen. The maxillule is described as "palp-like" It actually consists of two laminae originating from a common base. Contrary to Yamaguti the fifth leg is generally present in the male.

*Paralernanthropus* Hewitt closely resembles *Lernanthropus* but differs in the egg tubes being highly coiled as in *Sagum*. Whether this character alone is sufficient for creating a new genus is a matter of opinion.

I have in my collection three species which are of great interest. They are *L. lativentris* Heller (1868), *L. nemipteri* Jayasree and Pillai (1976) and *L. brevicephalus* Rangnekar (1956). In all these the anterior division of the trunk is more or less demarcated into two segments, the second and third trunk segments. On either side of the trunk there is a large wing-like lobe partially fused with the trunk. A careful study of *L. lativentris* has shown that the wings are the enlarged protopods of the third legs. In this character the above three species resemble *Aethon*. In *L. brevicephalus* the third legs have the protopods similar to those of *L. lativentris* but the endopod is absent and the exopod is an elytra similar to that of *Norion*. But all the three species have straight egg tubes as in *Lernanthropus* and the rami of their fourth leg are not distally whip-like. If the shape of the egg tubes is crucial, they must be placed in *Lernanthropus*, if not they can be placed in *Aethon* or *Norion*. I have taken this character as important as Hewitt has done and retained them in *Lernanthropus*. It must however be admitted that these three species to some extent bridge the gap between the various genera.

*Key to species of* **Lernanthropus**

| | | |
|---|---|---|
| 1. | Dorsal plate posteriorly cleft | .2 |
| — | Dorsal plate posteriorly not cleft | .6 |
| 2. | Posterior cleft shallow, not reaching the middle of the dorsal plate | .3 |
| — | Posterior cleft deep, almost reaching the base of the dorsal plate | .4 |
| 3. | Dorsal plate subequal to cephalothorax in size | *shishidoi* Shiino |
| — | Dorsal plate larger than cephalothorax | *.sphyraenae* Yamaguti and Yamasu |
| 4. | Third legs narrow and separate | *gibbosus* Pillai |
| — | Third legs fairly broad and basally fused | .5 |
| 5. | Third legs nearly reaching tip of dorsal plate, fifth leg present | *decapteri* Pillai |
| — | Third legs stopping far short of the tip of dorsal plate, fifth leg absent | .. *forficatus* Redkar *et al.* |
| 6. | Third leg uniramous | 7 |
| — | Third leg biramous | .18 |
| 7. | Dorsal plate tubular | *cruciatus* Pillai |
| — | Dorsal plate not tubular | .8 |
| 8. | Cephalothorax with postero-lateral horns | .9 |
| — | Cephalothorax without postero-lateral horns | .10 |
| 9. | Dorsal plate posteriorly rounded | *chrysophyrs* Shishido |

— Dorsal plate posteriorly angular ... ... .. *tylosuri* Richiardi
10. Fourth leg spiny ... ... ... ... 11
— Fourth leg not spiny ... ... ... ... ... 12
11. Exopod of fourth leg distally broader ... *lappaceus* Wilson
— Exopod of fourth leg distally not broader ... *trifoliatus* Bassett-Smith
12. Third leg elytra-like ... ... ... ... ... 13
— Third leg not elytralike ... ... ... ... ... 14
13. Third leg spiny, distally bilobed, cephalothorax larger than dorsal plate ... ... ... *chirocentrosus* Tripathi
— Third leg tubercular, distally not lobed, cephalothorax smaller than dorsal plate ... *brevicephalus* Rangnekar
14. Dorsal plate posterolaterally angular, leg three distally lobed ... ... ... ... *robustus* Pillai
— Dorsal plate posterolaterally rounded, leg three distally not lobed ... ... ... ... ... 15
15. Basal segment of antenna with stout process ... *latis* Yamaguti
— Basal segment of antenna without stout process ... ... ... ... ... ... ... 16
16. Fourth leg nearly as long as body ... ... ... *otolithi* Pillai
— Fourth leg shorter than body ... ... ... ... 17
17. Basal segment of antennule enlarged, held at right angles to second segment ... *pristipomoides* Kirtisinghe
— Basal segment of antennule normal ... ... ... *pami* Tripathi
18. Protopod of leg three projecting as large lobes on either side of trunk ... ... ... ... 19
— Protopod of leg three not projecting ... ... ... ... 20
19. Dorsal surface of body tubercular ... ... *lativentris* Heller
— Dorsal surface of body not tubercular *nemipteri* Jayasree and Pillai
20. Dorsal plate clearly broader than long ... ... ... 21
— Dorsal plate nearly as long as broad ... ... ... 23
21. Third legs separate ... ... ... *abitocephalus* Tripathi
— Third legs fused or contiguous ... ... ... ... 22
22. Dorsal plate twice as broad as long ... ... ... *sillaginis* Pillai
— Dorsal plate only slightly broader than long ... *opisthopteri* Pillai
23. Dorsal plate as broad as anterior division of trunk ... ... ... ... ... ... ... 24
— Dorsal plate broader than anterior division of trunk ... ... ... ... ... ... 26
24. Rami of leg four narrowing distalwards ... *dussumieri* Gnanamuthu
— Rami of leg four not narrowing distalwards ... ... ... 25
25. Rami of leg four distally broader ... ... ... *oblongus* Pillai
— Rami of leg four distally not broader .. *rubiginosus* Redkar *et al.*
26. Distal segment of antenna with prominent accessory process ... ... ... ... ... 27
— Distal segment of antenna without prominent accessory process ... ... ... ... ... 28
27. Cephalothorax with large antero-lateral processes, endopods of third legs fused ... *corniger* Yamaguti

— Cephalothorax anterolaterally rounded, endopods of third legs separate ... ... ... *secutoris* Pillai
28. Basal segment of antennule enlarged, placed at right angles to second segment ... ... *alatus* Pillai
— Antennule normal ... ... ... ... ... 29
29. Fifth leg present ... ... ... ... ... ... 30
— Fifth leg absent ... ... ... ... ... ... 33
30. Anterior division of trunk broader than dorsal plate ... ... ... ... ... ... 31
— Anterior division of trunk narrower than dorsal plate ... ... ... ... ... ... 32
31. Fifth leg reaching tip of caudal rami ... ... *indicus* (Pillai)
— Fifth leg clearly over reaching caudal rami ... *koenigii* Stp. & Lutk.
32. Dorsal plate circular, rami of leg four basally broad, narrowing distalwards ... ... *giganteus* Kroyer
— Dorsal plate roughly triangular, rami of leg four slender ... ... ... ... *sciaeni* Gnanamuthu
33. Distal border of dorsal plate nearly transverse ... ... ... 34
— Distal border of dorsal plate rounded ... ... ... 35
34. Fourth leg nearly as long as body ... ... *cadenati* Delamare-Deboutteville and Nunes-Ruivo
— Fourth leg much shorter than body ... ... *triangularis* Pillai
35. Endopod of fourth leg very small ... ... *engraulis* Tripathi
— Endopod of fourth leg normally developed ... *leiognathi* Tripathi

## **Lernanthropus abitocephalus** Tripathi
(Fig. 176)

*Lernanthropus abitocephalus* Tripathi, 1962a, p. 198, figs. 18-21.
*Lernanthropus pomadasysis* Rangnekar and Murti, 1961, p. 208, fig. 2.

*Female.*—Cephalothorax triangular, gradually widening backwards, much longer than broad, anteriorly evenly rounded and posteriorly trilobed. Antennular lobe not clearly indicated. Lateral parts folded downwards as long elliptic flaps. Anterior part of trunk nearly as long as broad, with convex sides. Dorsal plate much broader than long, antero-lateral edges curled downwards. Fourth and fifth segments fused into a large segment. Genital segment large. Abdomen short, broader than long. Caudal rami about twice as long as abdomen.

Antennule seven-jointed. Antenna stout, distal segment strongly curved, with swollen base, distal part grooved and well curved. Inner lobe of maxillule with one stout spine, outer lobe twice as

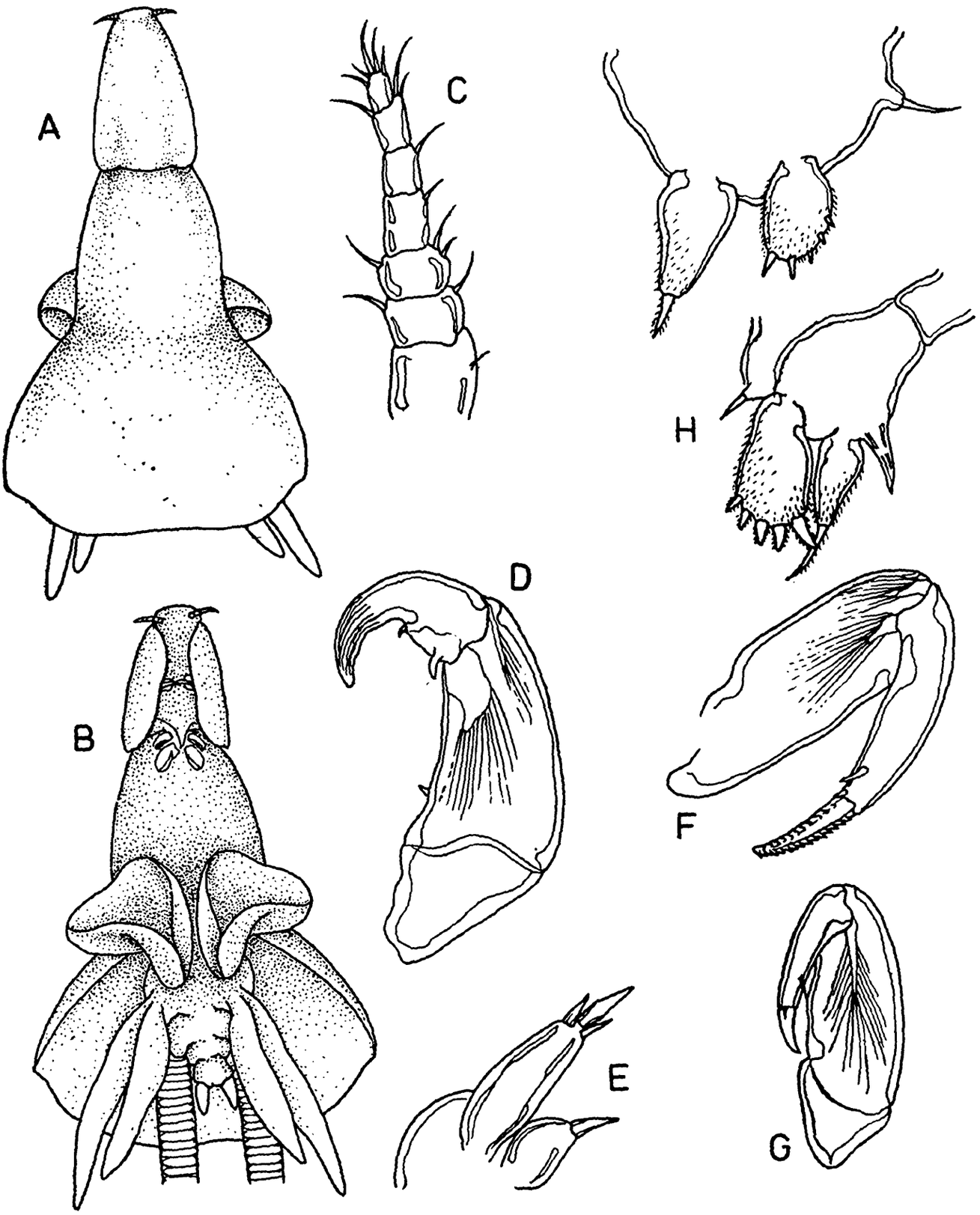


Fig. 176. *Lernanthropus abitocephalus* Tripathi : A, female, dorsal view; B, same, ventral view ; C, antennule ; D, antenna ; E. maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2.

long as inner, with three spines. Distal segment of maxillule as long as basal, with one distal spine, unguis unusually long, with dentate borders. Maxilliped slender, much smaller than antenna, distal segment with two spines, apex strongly curved

Exopod of first leg much larger than endopod, with five teeth, inner tooth large, endopod with pectinate apical spine, inner spine on basipod strong. Exopod of second leg smaller than endopod, with five small spines, endopod with short apical spine. Third leg biramous and separate, exopods directed outwards, endopods backwards. Fourth leg biramous, endopod shorter but slightly broader than exopod, both reaching beyond the dorsal plate. Fifth leg absent.

*Length.*—3.0 mm.

*Host.—Pomadasys maculatus.*

*Distribution.*—India (Puri, Bombay, Kerala).

*Remarks.*—Tripathi's illustrations are based on a mounted specimen and he has not given details of the appendages. However to a certain extent they apply to my specimen collected from the same host. Rangnekar and Murti described material collected from the type host as *L. pomadasysis.* It is very likely that this is a synonym of Tripathi's species. Unfortunately their description contains a few obvious mistakes. For example in typical members of the genus the dorsal plate is not separated from the trunk by a septum like the one they have shown. The dorsal plate is described as "unequally divided" Though they have described the fifth leg it is absent in this species. The outer ramus of the maxillule is only one-jointed, the basal segment mentioned by them is the basal lobe giving rise to the two lobes. Rangnekar and Murti confused the first and second legs. They have described the exopod as two-segmented and the spine on the basipod as three-jointed. This cannot be so.

Notwithstanding the differences I feel sure that the three collections are identical, especially since the host is the same.

## **Lernanthropus alatus** Pillai
(Fig. 177)

*Lernanthropus alatus* Pillai, 1964a, p. 46, fig. 8 ; 1967d, p. 1625, fig. 145.

*Female.*—Cephalothorax longer than broad, gradually widening backwards, posteriorly evenly curved and overlapping trunk. Lateral parts forming narrow ventrally directed lobes projecting antero-laterally as small lobes. Anterior division of trunk short but broad, postero-laterally forming linguiform lobes fusing with the third pair of legs. Dorsal plate irregularly rounded, as broad as trunk. Fourth, fifth and genital segments partially fused. Abdomen large, broader than long. Caudal rami as long as abdomen.

Basal segment of antennule expanded into a large lobe projecting in front of the antennular lobe, with small spinules on the ventral side, rest of the appendage placed at right angles ot the basal segment. Antenna stout, distal segment with swollen base giving the appendage a characteristic appearance. Inner lobe of maxillule comparatively large, with a stout but short spine, outer lobe with three spines. Distal segment of maxilla short, distally spiny and with two forked processes rather than spines, unguis bilaterally dentate. Distal segment of maxilliped strongly curved.

Exopod of first leg large, with five stout teeth, endopod with a fairly long pectinate spine. Second leg much smaller than first, exopod with the second spine from outside small, apical spine of endopod short. Third leg biramous, exopod fused with the trunk, endopods partially fused and linguiform. Fourth leg long and slender, reaching far beyond the dorsal plate, endopod slightly shorter than exopod. Fifth leg very short.

*Length.*—3.9 mm.

*Host.*—*Selaroides leptolepis.*

*Distribution.*—India (Kerala).

*Holotype* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 4440/1.

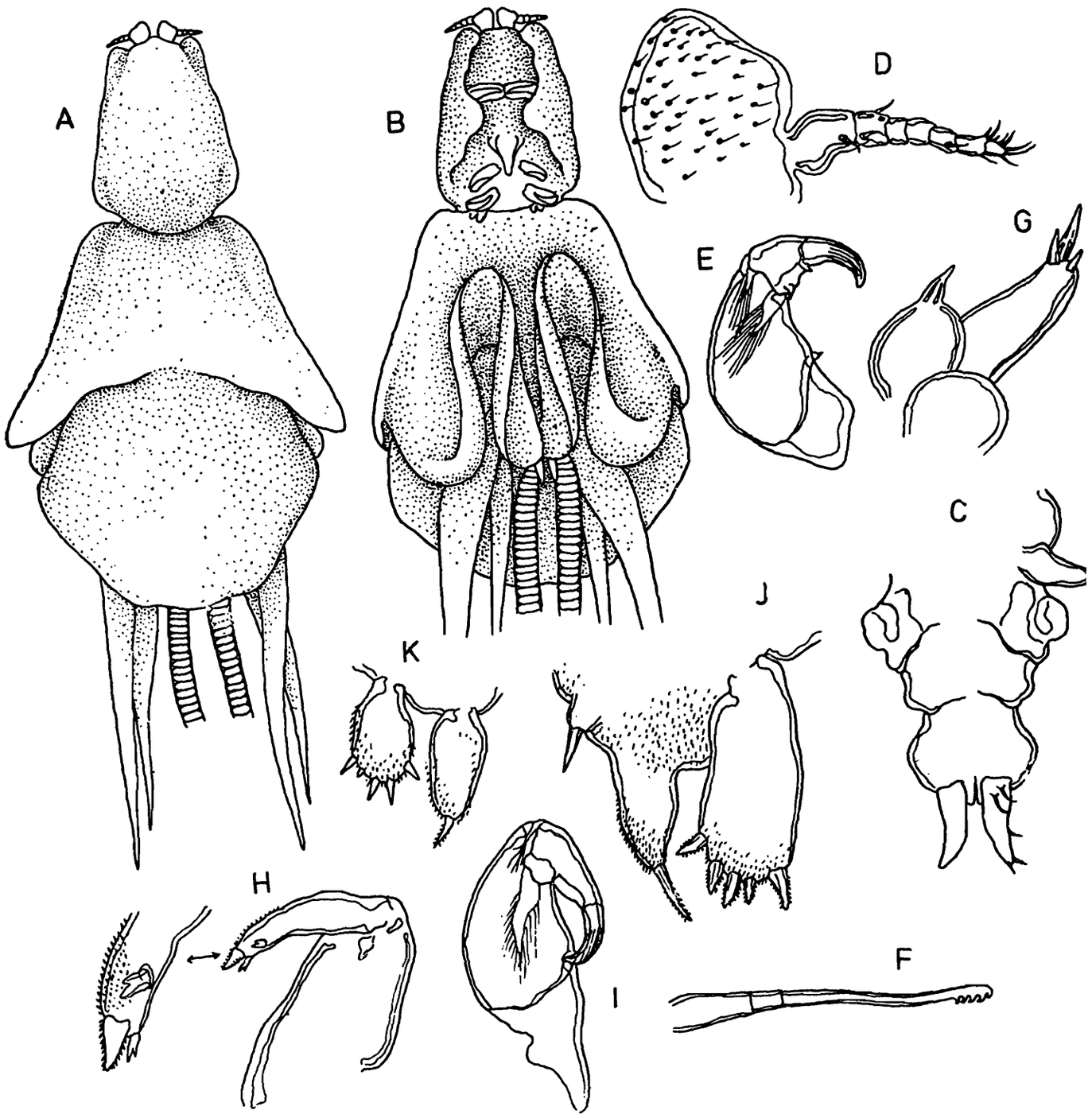


Fig. 177. *Lernanthropus alatus* Pillai : A, female, dorsal view ; B, same, ventral view ; C, hind part of trunk ; D, antennule ; E, antenna ; F, mandible ; G, maxillule ; H, maxilla ; I, maxilliped ; J-K, legs 1-2.

*Remarks.*—The peculiar expansion of the basal segment of the antennule distinguishes this species.

Compared to my earlier description the present specimens would appear to be different. This is only because while mounting the

specimen the third legs which are fused with the trunk got spread out making the body much broader than it actually is.

### **Lernanthropus brevicephalus** Rangnekar
(Fig. 178)

*Lernanthropus brevicephalus* Rangnekar, 1957a, p. 12, fig. 3 ; Yamaguti, 1963, p. 147, pl. 155, fig. 5 ; Pillai, 1967d, p. 1634, fig. 170.

*Female.*—Cephalothorax longer than broad, gradually widening backwards and posteriorly overlapping the trunk. Antennular lobe large and well demarcated. Anterior division of trunk nearly equal in length and width. Dorsal plate very large, as long as the body in front, roughly ovate, broadest at the anterior one third and further on gradually narrowing backwards, hind border evenly rounded. Fourth, fifth and genital segments fused together. Abdomen nearly circular in outline. Caudal rami partially fused with abdomen, longer than the latter. Dorsal side of the body, the dorsal plate and the third legs pustulose, pustules more numerous laterally.

Antennule rather stout and six-jointed, basal segment large, distal segment very small, setae plumose. Antenna stout, with characteristic shape, basal segment proximally very broad, distal segment comparatively short but stout and basally swollen. Inner lobe of maxillule comparatively large, with a spine and a cusp, outer with three spines, one of them very small. Distal segment of maxilla with a stout curved subapical claw and a bifid apical spine, unguis with strongly dentate borders. Maxilliped much smaller than antenna, distal segment apically slightly curved.

Basipod of first leg spiny, exopod with five short, subsimilar teeth, endopod slender, with apical spine. Rami of second leg rather deformed, exopod with two small teeth, endopod without spine, longer than exopod. Third leg uniramous and elytra-like, completely hiding the posterior part of trunk and caudal rami, with a proximal outer tubercle carrying a setule. Its basipod partially fused with the anterior division of trunk and remaining on either side of the trunk as wing-like expansions curved ventralwards. Fourth leg biramous, rami subsimilar, reaching far beyond the dorsal plate. Fifth leg very small.

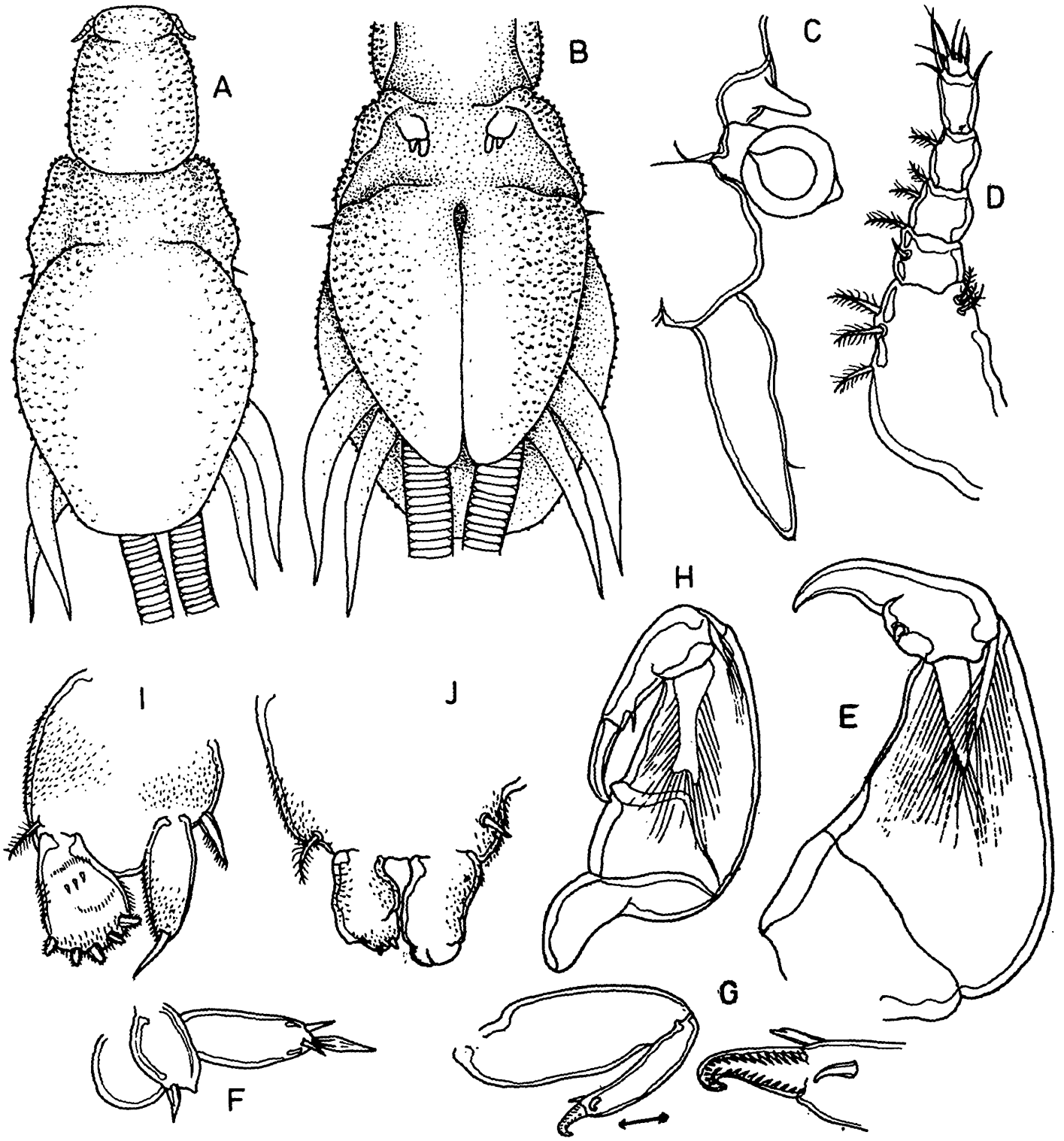


Fig. 178. *Lernanthropus brevicephalus* Rangenekar : A, female, dorsal view ; B, same, hind part, ventral view ; C, hind part of trunk ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H, maxilliped ; I-J, legs 1-2.

*Length.*—4.0 mm.

*Host.*—*Lutianus* sp., *L. sanguineus.*

*Distribution.*—India (Bombay, Kerala).

*Remarks.*—Rangnekar's description of this species is adequate but needs some correction. What she has described as head is only the antennular lobe which is unusually well developed in this species. I could not see the "muscle discs" she has mentioned as present on the ventral side of the cephalothorax. There is no collar-like neck between the cephalothorax and the trunk nor is the dorsal plate separated from the anterior division of trunk as illustrated by her. The wings she has shown on the trunk are the basipods of the third legs and the setae are on the legs and not on the trunk. The antennule is distinctly segmented and the basal segment does not have a "bunch of hairs" The description of the first and second legs is unsatisfactory.

This species as explained earlier is of much taxonomic interest. As in *Sagum* and *Norion* the third legs form elytra—like coverings for the hind part of the body and their protopods form prominent lobes on either side of the anterior division of the trunk recalling the condition in *Aethon.* But the fourth legs and egg tubes are exactly as in *Lernanthropus.*

It is very significant that this species has tubercles on the exposed parts of the body and these regions are dark brown in colour. A similar condition is evident in anthosomatids parasitic on perches. In fact anthosomatids parasitic on perches, irrespective of the genera to which they belong, show some uniformity in characters like the colouration of the body and tuberculation. The third leg shows all grades of modifications from the typical condition in *Lernanthropus* to the highly modified form in *Norion.*

### **Lernanthropus cadenati** Delamare-Deboutteville and Nunes-Ruivo
(Fig. 179)

*Lernanthropus cadenati* Delamare-Deboutteville and Nunes-Ruivo, 1954b, p. 145, figs. 2-3 ; Pillai, 1966, p. 138, fig. 9 ; 1967d, p. 1634, fig. 171.

*Female.*—Cephalothorax roughly squarish, with rounded corners, anterior border trilobed, posterior convex, overlapping trunk. Trunk as broad as long, broader than cephalothorax, antero-laterally shoulder-like and demarcated from dorsal plate by only

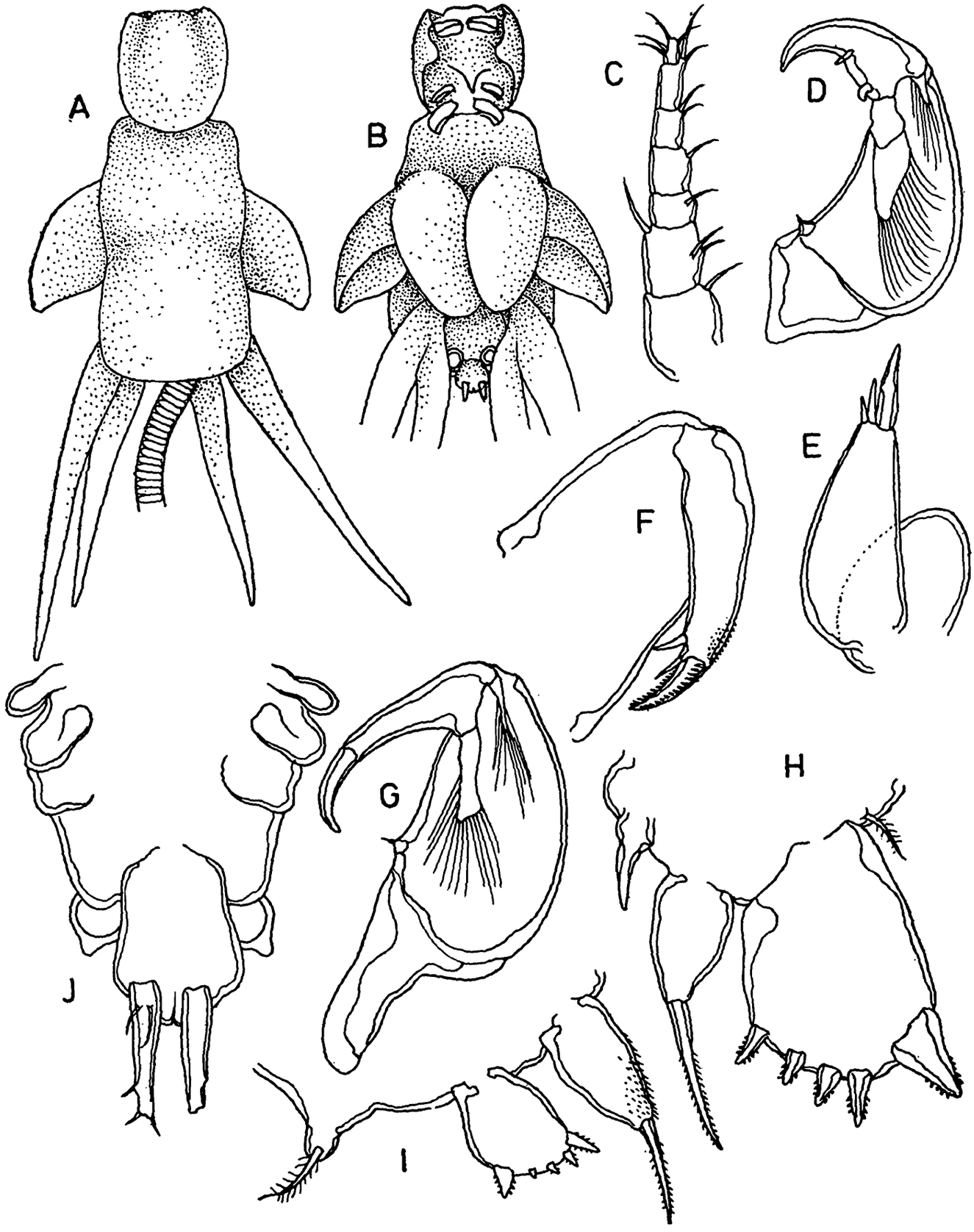


Fig. 179. *Lernanthropus cadenati* Delamare-Deboutteville and Nunes-Ruivo : A, female, dorsal view ; B, same, ventral view ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2 ; J, hind part of trunk.

a slight constriction. Dorsal plate as broad as trunk but shorter, broader than long. Trunk fused with exopods of third legs. Fifth and genital segments fused into a fairly large segment. Abdomen very large, longer than broad. Caudal rami long, with two proximal, two distal and one outer setae. Egg sacs very long, longer than the fourth legs.

Antennule seven-jointed and sparsely setose, the surface of the cephalothorax between the insertion of the antennules spiny. Antennae rather stout, basal part of distal segment broad, with two spines, one blunt and the other sharp, claw stout, short and curved. Inner lobe of maxillule comparatively large, apparently without spine, outer lobe with three spines, one of them stout. Basal segment of maxilla stout, distal with two sharp distal spines and a patch of denticles, unguis sharp and bilaterally dentate. Maxilliped strongly built, basal segment stout, proximally produced into a large lobe, distal segment very slender, apparently without armature.

Exopod of first leg very stout, nearly equal in length and width, with five sparsely dentate teeth, outer tooth exceptionally large. Endopod comparatively small, with a long pectinate spine-like seta. Basipod with outer seta and inner spine. Exopod of second leg small, shorter than endopod, outer and inner teeth fairly large, others very small, outer seta on basipod placed far away from exopod and mounted on a projecting lobe. Third legs biramous, rami subequal in size, exopods fused with the trunk. Fourth legs long, slightly longer than trunk, exopod longer. Fifth leg a small lobe.

*Length.*—4.3 mm.

*Host.—Elops senegalensis, Megalops cyprinoides.*

*Distribution.*—Senegal, India (Kerala).

*Remarks.*—The description presented here differs from the original description and the subsequent one by Pillai. In the present specimens the distal segment of the maxilla has two spines instead of a forked spine. These differences are clearly intraspecific variations. This species can be easily distinguished by the shape of the body and the long fourth legs. The first and second legs are very characteristic.

## **Lernanthropus chirocentrosus** Tripathi
(Fig. 180)

*Lernanthropus chirocentrosus* Tripathi, 1962a, p. 200, figs. 24-25, Pillai and Natarajan, 1977, p. 40, figs. 117-126.

*Female.*—Cephalothorax comparatively very large, irregular in outline, lateral lobes large, antero-laterally produced into large rounded lobes, hind border overlapping trunk. Anterior part of trunk broader than long, antero-laterally shoulder-like. Dorsal plate as long as anterior part of trunk, broader than long and demarcated from the trunk by lateral constrictions, its hind border irregularly rounded. Fifth and genital segments fused into a large segment. Abdomen short, proximally narrow, distally bilobed. Caudal rami originating from the ventral side of abdomen, much longer than broad, with two dorsal and one inner setae and three distal spines, its surface covered with spinules. Egg sacs very long.

Antennule eight-jointed and directed somewhat forwards, its basal segment large and swollen. Antenna very stout, distal segment massive, with grooved chitinised unguis. Below the unguis there is a broad conical accessory process covered with pustules. Inner lobe of maxillule apparently without spines, outer lobe long and slender, with three spines. Distal segment of maxilla longer than basal, its distal half with two patches of sharp denticles and a long spine, unguis bilaterally dentate. Maxilliped much smaller than the antennae, basal segment with three patches of strong denticles.

Basipod of first leg heavily spiny, with outer and inner setae, exopod large, with five stout claws, endopod small, with a long apical spine, both rami with large spinules. Basipod of second leg spiny, outer seta mounted on a tubercle, exopod with five small claws, endopod with none, both rami strongly spinulose. Third legs apparently uniramous, elytra-like and overlapping along the median line, their distal border bilobed, laterally projecting beyond the dorsal plate, ventral surface covered with spinules. Fourth leg biramous, with short subsimilar rami, narrowing distalwards. Fifth leg a small stump.

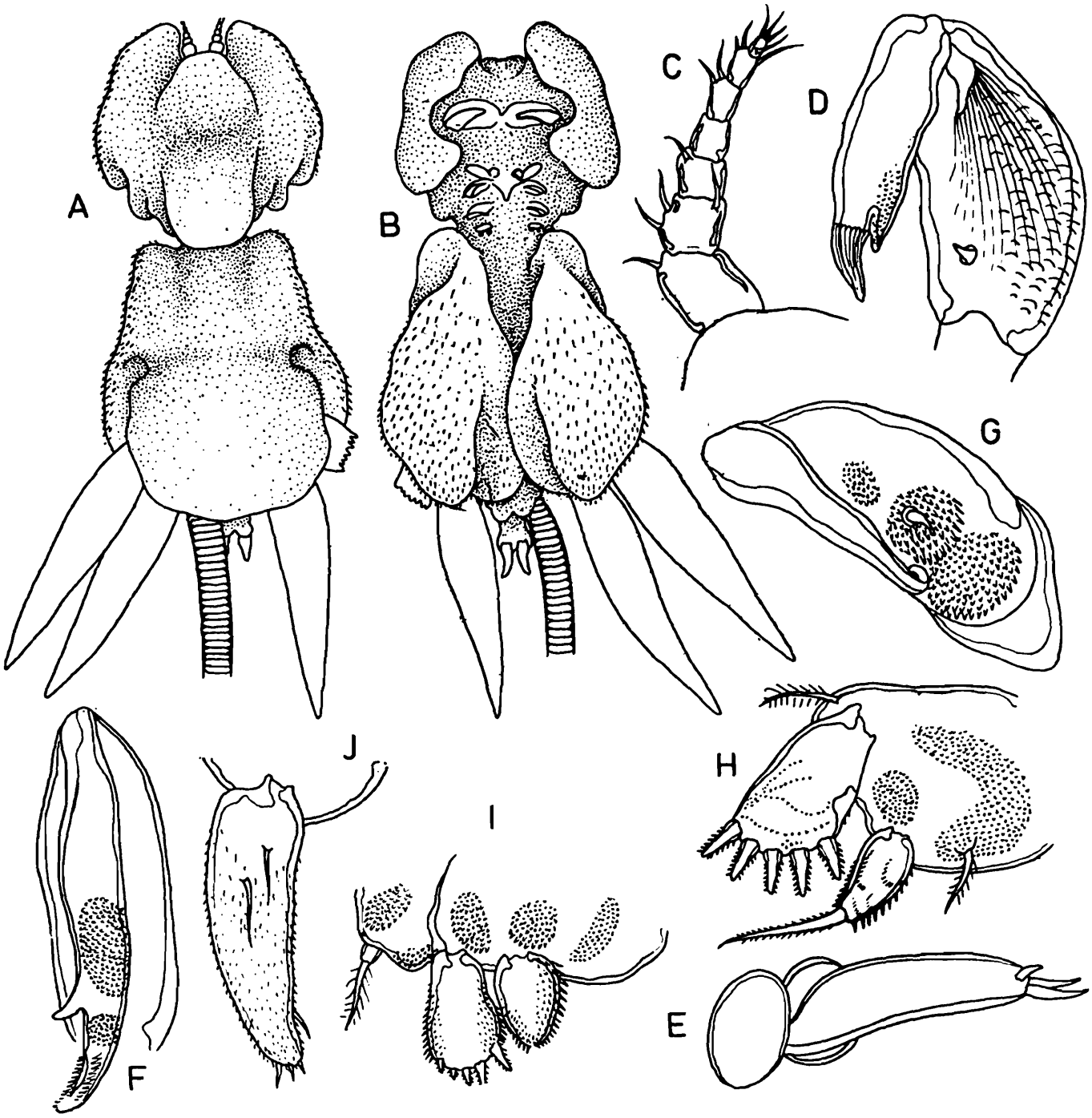


Fig. 180. *Lernanthropus chirocentrosus* Tripathi : A, female, dorsal view ; B, same, ventral view; C, antennule; D, antenna; E, maxillule; F, maxilla ; G, maxilliped ; H-I, legs 1-2.

*Length.*—3.3 mm.

*Male.*—Much smaller than female but the antennae and maxillipeds comparatively large. Third and fourth legs uniramous, fourth much longer and broader than third.

*Length.*—1.6 mm.

*Host.—Chirocentrus dorab, Thrissocles hamiltonii.*

*Distribution.*—India (Puri, Chilka lake, Kerala)

*Remarks.*—This species shows unusual characters particularly in the shape of the body and the third legs. The latter reminds one of the third legs of *Aethon* and *Norion*. The antennae, maxillae and maxillipeds are armed with patches of strong spines. The first two pairs of legs are also conspicuously spiny. The original description though correct in essentials failed to bring out important details.

The description of the male is based on Tripathi's publication.

### **Lernanthropus chrysophrys** Shishido

*Lernanthropus chrysophrys* Shishido, 1898, p. 337, figs. 1-4 ; Yamaguti, 1936b, p. 15, pl. 9, figs. 92-97 ; 1963, p. 148, pl. 160, fig. 1 ; Shiino, 1955a, p. 62, fig. 5 ; Tripathi, 1962a, p. 202, fig. 26.

*Host.—Sparus macrocephalus, S. longispinis, Chrysophrys berda.*

*Distribution.*—Japan, India (Port Canning).

*Remarks.*—This species is included here as Tripathi recorded it from Port Canning. Shiino has given an excellent description which is summarised below.

Cephalothorax somewhat triangular, anteriorly trilobed and postero-laterally produced into large slightly curved horns as in *L. tylosuri*. Anterior division of trunk roughly cylindrical, nearly as long as broad. Dorsal plate nearly circular, demarcated from anterior division of trunk by deep constriction. Genital segment and abdomen distinct, latter sharply widening. Caudal rami long.

Antennule indistinctly seven-jointed, associated with an appendix. Antenna rather slender, distal segment strongly curved. Inner lobe of maxillule with a stout spine, outer with two slender spines. Distal

segment of maxilla with a spine and a few denticles, unguis irregularly dentate. Maxilliped with stout basal segment. Exopod of first leg with five similar and that of second with four dissimilar teeth, endopod of both with a stout spine. Third legs uniramous, longitudinally folded. Fourth leg with similar rami reaching well beyond the dorsal plate.

### **Lernanthropus corniger** Yamaguti
(Fig. 181)

*Lernanthropus corniger* Yamaguti, 1954, p. 387, figs. 35-41 ; 1963, p. 148, pl. 161, fig. 1 ; Pillai, 1963c, p. 660, fig. 3 ; 1967d, p. 1629, fig. 157.

*Lernanthropus kanagurta* Tripathi, 1962a, p. 194, figs. 10-14.

*Female.*—Cephalothorax, anterior division of trunk and the dorsal plate forming subequal, subcircular divisions. Anterolateral parts of cephalothorax bent downwards and also forwards as a pair of large horns. Anterior division of trunk with two lateral constrictions probably indicating the fusion of segments, posterolaterally prolonged into large lobes which apparently are the exopods of the third legs fused with the trunk. Dorsal plate anteriorly narrowed, with even border. Fifth segment distinct but very short. Genital segment large and swollen. Abdomen one-jointed. Caudal rami as long as abdomen.

Basal segment of antennule swollen, its surface with scattered spinules. Basal segment of antenna with a large inner process, distal segment roughly rectangular and ending in a short process overlapping a grooved rectangular lobe. Both lobes of maxillule fairly large, proximal inner part of outer lobe strongly spiny, median distal spine large, inner lobe with a short spine. Basal segment of maxilla stout, distal segment with two spines and a few blunt teeth, unguis with strong teeth. Maxilliped swollen, distal segment apically sharply curved.

Exopod of first leg stout, with five large barbed teeth, endopod well developed, with a long pectinate seta. Second leg much smaller than first, endopod without apical spine. Third legs biramous, exopods folded lengthwise, endopods fused, with the edges curled. Fourth leg with subsimilar rami reaching far beyond the dorsal plate. Fifth leg absent.

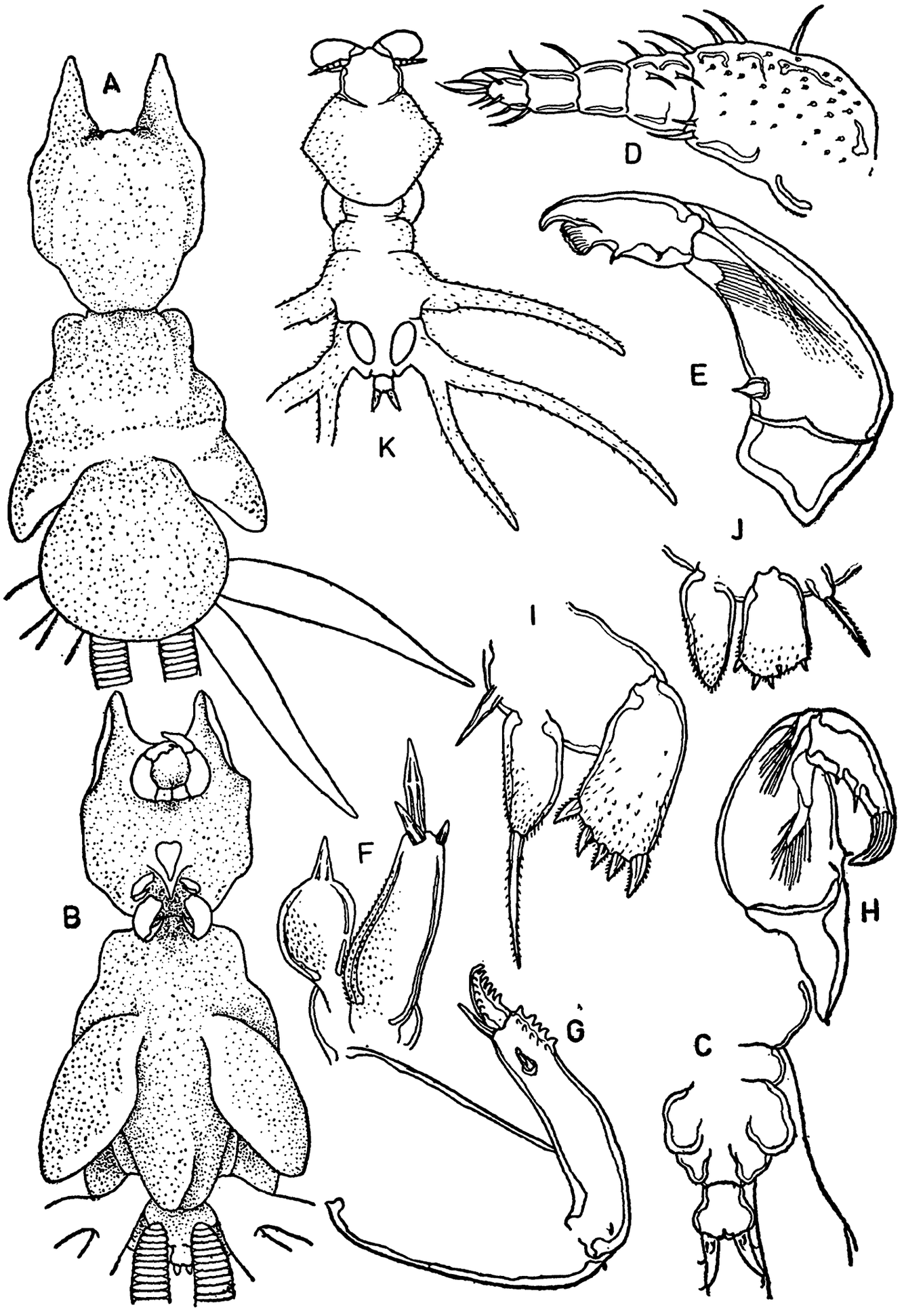


Fig. 181. *Lernanthropus corniger* Yamaguti : A, female, dorsal view ; B, same, ventral view ; C, same, posterior part of trunk ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H, maxilliped ; I-J, legs 1-2 ; K, male.

*Length.*—3.1 mm.

*Male.*—Cephalothorax triangularly produced in the middle of its lateral borders, antennular lobe large and set off by a transverse groove. Trunk segments faintly indicated. Fourth segment fully fused with genital segment. Abdomen small but distinct. Caudal rami with five setae. Dorsal side of body and of third and fourth legs spinulose. Third leg uniramous, endopod indicated. Fourth leg biramous, exopod longer than endopod.

*Length.*—1.9 mm.

*Host.*—*Megalaspis cordyla*, *Rastrelliger kanagurta.*

*Distribution.*—Japan, India (Kerala, Puri).

*Remarks.*—The single specimen described by Yamaguti has blunt horns on the cephalothorax. The present study based on a large number of specimens shows that depending on preservation and the pressure of the cover glass while mounting for study the ventral fold may partially spread out changing the shape of the horns. The shape of the body and the structure of the antenna and maxilla distinguish this species.

It is with some hesitation that I make *L. kanagurta* Tripathi a synonym of *L. corniger*. Tripathi obviously prepared his illustrations from permanent mounts. But the antenna shows its identity.

### **Lernanthropus cruciatus** Pillai
(Fig. 182)

*Lernanthropus cruciatus* Pillai, 1962b, p. 613, fig. 1 ; 1967d, p. 1633, fig. 169.

*Female.*—Cephalothorax nearly equal in length and width, lateral lobes moderately deep and with a membranous flange. Anterior part of trunk cylindrical, about twice as long as broad. Dorsal plate twice as long as anterior part of trunk, laterally compressed, hind border truncate. Fourth and fifth segments indistinct. Genital segment moderately large. Abdomen small. Caudal rami very long.

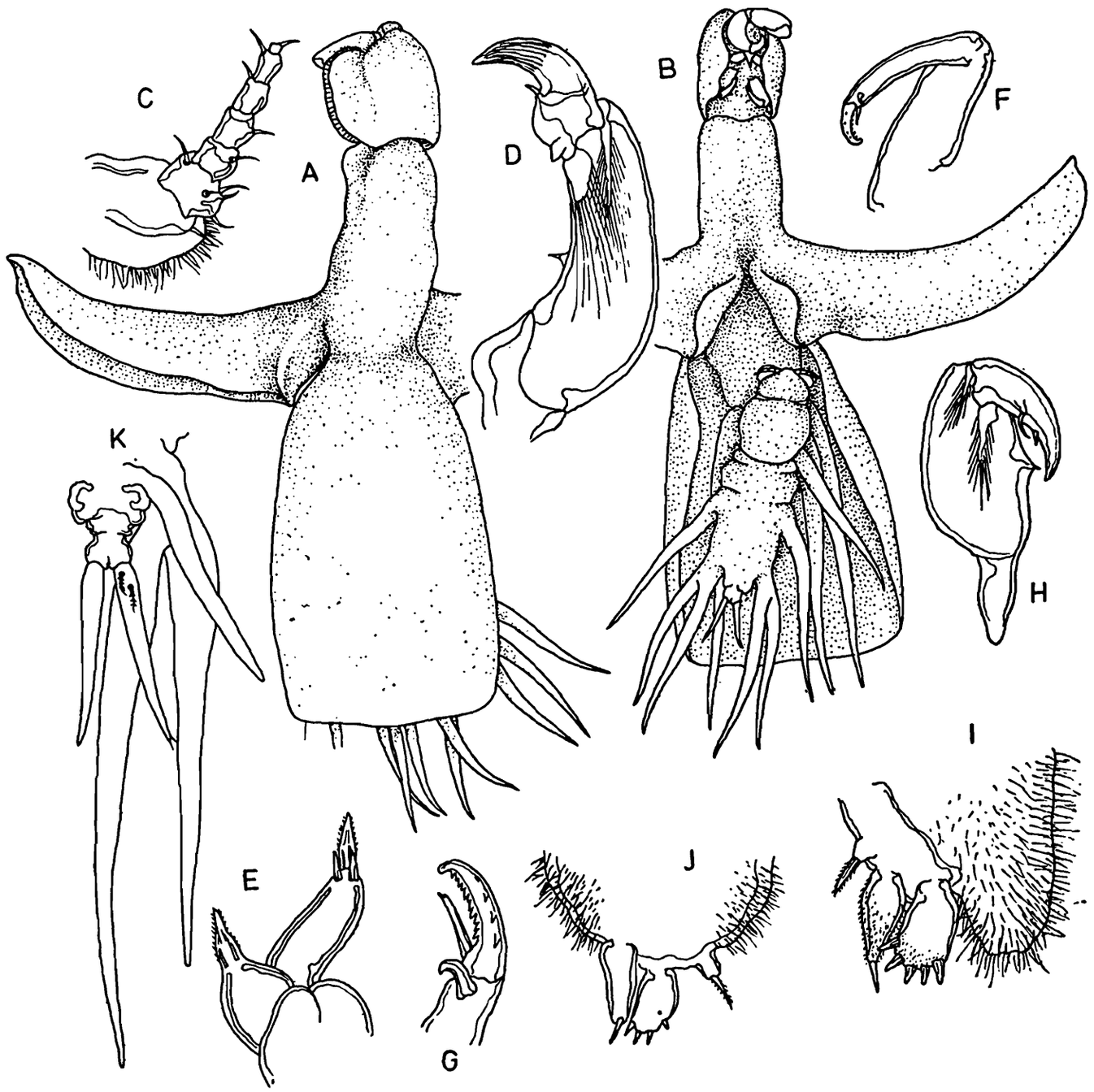


Fig. 182. *Lernanthropus cruciatus* Pillai : A, female, dorsal view ; B, same, ventral view, with male attached ; C, antennule ; D, antenna ; E, maxillule F, maxilla ; G, same, tip enlarged ; H, maxilliped ; I-J, legs 1-2 ; K, posterior part of body.

Antennule comparatively small, seven-segmented, associated with a hairy pad. Antenna rather slender, very much like that of *L. robustus*, distal segment short but stout, with swollen base, distal part well chitinised. Inner lobe of maxillule large, with a stout pectinate spine, outer with three spines, middle spine stout. Maxilla

slender, distal segment curved, with a stout, short, curved process and a long spine, unguis sparsely dentate. Maxilliped robust, distal segment comparatively broad.

Basipod of first leg externally produced into a conical hairy lobe, exopod with five strong teeth, endopod longer than exopod, with a short spine. Basipod of second leg with inner and outer patch of hairs, exopod with four small teeth, outer seta on basipod mounted on a swollen base. Third leg uniramous, longitudinally folded, endopod indicated by a basal lobe. Fourth leg birmaous, rami long, reaching beyond dorsal plate, endopod slightly longer than exopod. Fifth leg slender, nearly reaching the tip of the caudal rami.

*Length.*—16.3 mm.

*Male.*—Cephalothorax longer than broad, with large antennular lobe. Thoracic segments indicated. Genital segment and abdomen rather short. Caudal rami long, about five times as long as abdomen. Third leg uniramous, endopod indicated by a lobe. Fourth leg biramous, endopod longer than exopod. Fifth leg absent.

*Length.*—2.8 mm.

*Host.*—Sciaenid.

*Distribution.*—India (Kerala).

*Holotype and allotype* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2150/2 ; C 2151/2.

### **Lernanthropus decapteri** Pillai
(Fig. 183)

*Lernanthropus decapteri* Pillai, 1964a, p. 57, fig. 14 ; 1967d, p. 1624, fig. 144.

*Female.*—Cephalothorax slightly longer than broad, lateral parts bent downwards as two large flaps, projecting in front as two horns. Dorso-median part forming two low bosses. Anterior division of trunk nearly squarish and continued as the dorsal plate, antero-lateral parts shoulder-like. Dorsal plate large, postero-medially

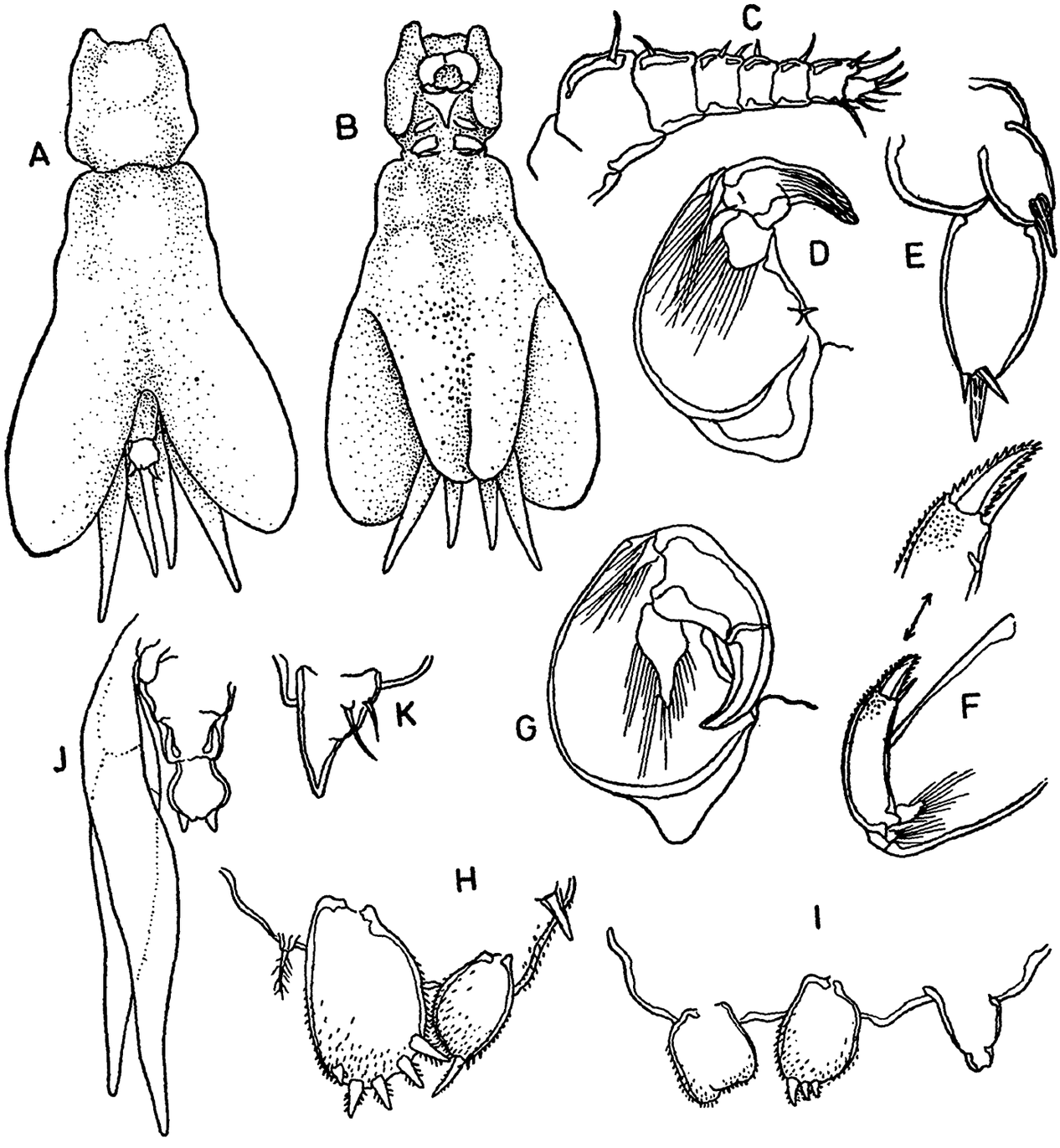


Fig. 183. *Lernanthropus decapteri* Pillai : A, female, dorsal view ; B, same, ventral view ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2 ; J, hind end of body ; K, caudal ramus.

cleft, the cleft extending to about two thirds its total length, exposing part of the genital segment and the whole of the abdomen. Antero-median part of trunk with a small boss.

Antennule rather short but stout, seven-to eight-jointed, with comparatively short setae. Basal segment of antenna very stout, with proximal process carrying a spine, distal segment short and rather stumpy, with swollen base. Inner lobe of maxillule with one stout spine, outer with one stout and two small spines. Distal segment of maxilla rather short, with one distal spine, unguis small, dentate. Maxilliped very strongly built, basal segment only slightly longer than broad, distal segment stout and strongly curved.

Basipod of first leg with outer seta mounted on a small base and an inner spine, exopod large, with five barbed teeth, first tooth small, endopod comparatively small, with small apical spine. Rami of second leg subequal in size, exopod with three small spines, base of the outer seta on basipod large and projecting, seta absent. Third legs uniramous, almost fully fused into a triangular apically bilobed lamina fully hiding the hind part of trunk and the caudal rami. Fourth leg biramous, rami short and subsimilar, exopod slightly longer, reaching beyond the dorsal plate. Fifth leg small.

*Length.*—3.4 mm.

*Host.—Decapterus russelli*

*Distribution.*—India (Kerala)

*Type* in the National Zoological Collection at Zoological survey of India, Calcutta. Reg. No. C 4449/1.

*Remarks.*—This species closely resembles *L. forficatus* Redkar et al. as described in this work. However it can be distinguished by small differences like the presence of bosses on the cephalothorax and trunk, the length of the third legs, the shape of the lobes of the maxillule and the nature of the rami of legs one and two. Above all in *L. decapteri* the fifth leg is present but absent in *L. forficatus*. The caudal rami are totally different in these two species.

### **Lernanthropus dussumieri** Gnanamuthu

(Fig. 184)

*Lernanthropus dussumieria* Gnanamuthu, 1948b, p. 209, figs. 1-6 ; Yamaguti, 1963, p. 148 ; Pillai, 1967d, p. 1628, fig. 154.

*Female.*—Cephalothorax slightly longer than broad, narrowing backwards and overlapping trunk. Antennular lobe low but distinct, antero-lateral lobes rounded, not overreaching antennular lobe. Anterior division of trunk demarcated from dorsal plate only by a pair of small lateral bulgings, the two together oblong, dorsal plate longer. Fourth and fifth segments fused. Genital segment distinct, much broader than long. Abdomen nearly circular. Caudal rami with four setae, inner distal seta spiniform, with swollen middle part.

Antennule seven-segmented, basal segment moderately enlarged. Antenna stout, basal segment broad, distal segment with broad base. Inner lobe of maxillule with one spine, outer lobe slender and long, median spine large and pectinate. Distal segment of maxilla with two spines and an arc of small teeth, unguis with dentate borders. Maxilliped much smaller than antenna, basal segment broad, distal strongly curved.

Exopod of first leg with inner and outer teeth longer than others' endopod fused with basipod, with a short apical spine. Second leg smaller than first, exopod with three and endopod with one tooth, both legs prominently spiny. Rami of third leg fused, exopod fused with trunk, endopods forming a distally bilobed tongue-like expansion, free borders of the rami curled. Fourth leg projecting far beyond the dorsal plate, exopod much longer than endopod. Fifth leg very small, with an apical spine.

*Length.*—2.5 mm.

*Host.—Dussumieria acuta.*

*Distribution.*—India (Kerala, Madras).

*Remarks.*—As Gnanamuthu's description is defective a comparison is difficult. However the identity of the present specimens need not be doubted. Gnanamuthu described two triangular antero-lateral flaps fused with the ventral flaps of the cephalothorax. There are not such flaps but in mounted specimens the lateral flaps would appear exactly as illustrated by Gnanamuthu. The antennular segments are not produced into spines. The mandibles are

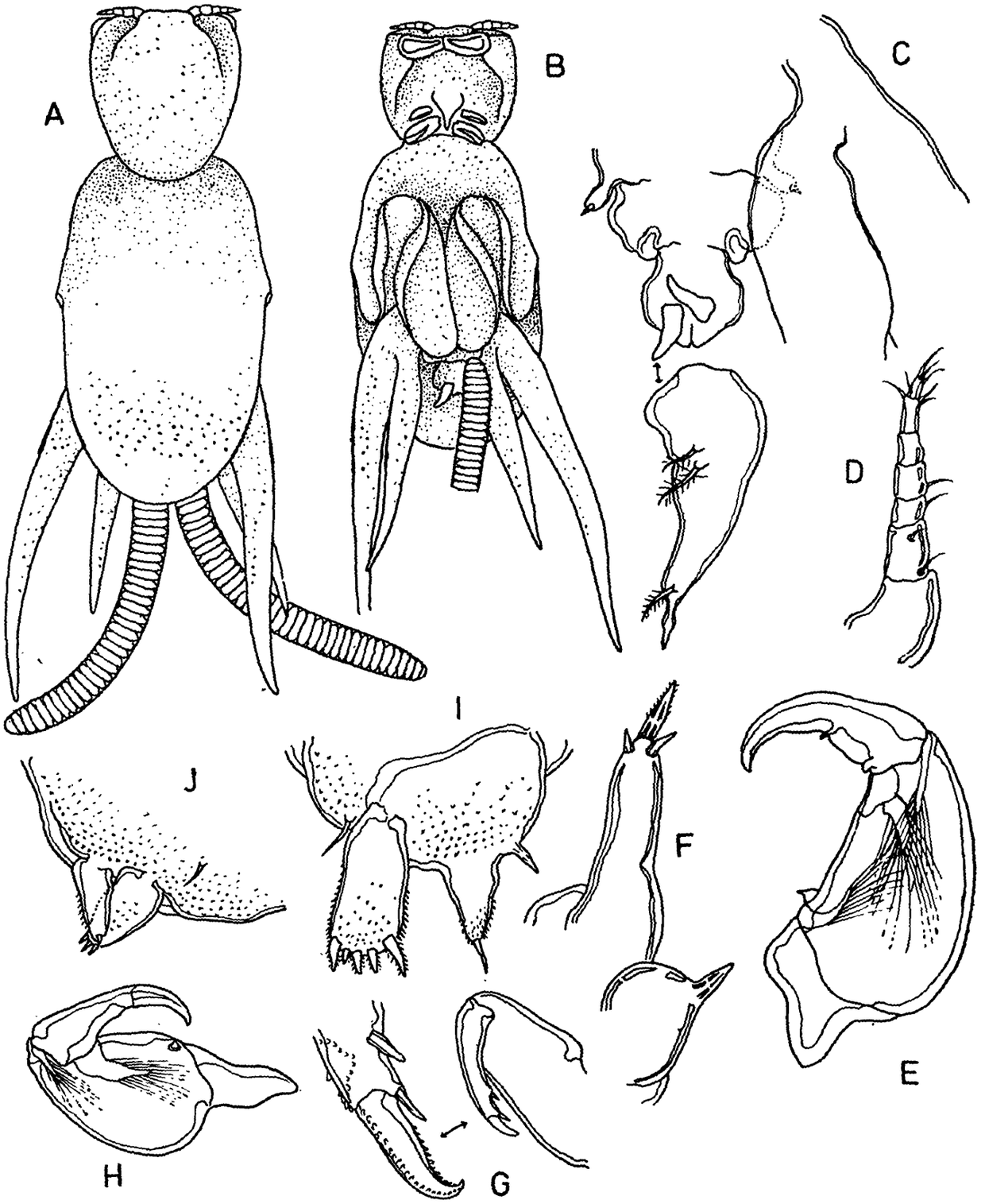


Fig. 184. *Lernanthropus dussmieri* Gnanamuthu : A, female, dorsal view ; B, same, ventral view; C, posterior part of trunk; D, antennule; E, antenna; F, maxillule ; G, maxiilla ; H, maxilliped ; I-J, legs 1-2.

illustrated as having long setiform spines. This cannot be so. Gnanamuthu described the maxillule as biramous, each ramus two-jointed. This appendage is two lobed as usual. Gnanamuthu described the first two trunk segments as free. They are not. His description of the first two legs is not correct, the same is true of the explanation of the figures.

The type is not in the Indian Museum, nor is any other specimen available.

### **Lernanthropus engraulis** Tripathi

*Lernanthropus engraulis* Tripathi, 1962a, p. 197, figs. 15-17.

*Female.*—Cephalothorax nearly circular in outline, lateral parts folded downwards into moderately large flaps. Anterior division of trunk continued imperceptibly into the dorsal plate, the two together nearly oval in shape, fully covering the posterior division of the trunk excluding the caudal rami. Genital segment rounded, abdomen small, about half the width of the genital segment.

Antennule six-jointed, third segment with one and sixth with three setae ? Distal segment of antenna with a small median inner spine. Outer lobe of maxillule with one apical spine, inner lobe with one seta. Basal segment of maxilla swollen in the middle. Third legs biramous, rami subsimilar. Fourth leg with long exopod nearly of the same width throughout, almost as long as the body, endopod a very small lobe. Fifth leg apparently absent.

*Length.*—1.8 mm.

*Host.—Setipinna phasa.*

*Distribution.*—India (Hoogly).

*Remarks.*—The above description is after Tripathi. Tripathi's description contains no details of the appendages but the fourth leg is very characteristic. As observed by Tripathi *L. engraulis* closely resembles *L. heteropodus* Yu particularly in the shape of the fourth legs. But in *L. heteropodus* the endopods of the third legs are fused but separate in *L. engraulis.*

## **Lernanthropus forficatus** Redkar, Rangnekar & Murti (Fig. 185)

*Lernanthropus forficatus* Redkar et al, 1949, p. 43, figs. 25-35 ; Yamaguti, 1963, p. 148 ; Pillai, 1967d, p. 1629, fig. 158.

*Female.*—Cephalothorax rounded, nearly as long as broad. Lateral lobes large, projecting in front as large rounded lobes. Antennular lobe small, as broad as lateral lobes. Anterior part of trunk regularly broadening backwards, antero-laterally shoulder-like and antero-medially produced forwards into a lobe overlapping cephalothorax. Dorsal plate only slightly longer than anterior part of trunk, deeply cleft, the two halves broadening and diverging. Fourth, fifth and genital segments fused into a large segment. Abdomen large, as long as broad. Caudal rami short and conical, about a third of the length of the abdomen.

Antennule comparatively stout, seven-segmented. Antenna robust, basal segment proximally broad, distal segment short but stout, somewhat irregular. Inner lobe of maxillule with one and outer with three spines. Distal segment of maxilla distally spinulose and with one long spine, unguis with dentate borders. Maxilliped much smaller than antenna, basal segment rather swollen, distal with broad base and curved claw.

Exopod of first leg large, with five teeth, endopod small, without apical spine. Second leg small, exopod with four small teeth. Third leg apparently uniramous, basally fused and distally free, forming a triangular posteriorly directed lobe covering the hind part of the trunk. Fourth leg biramous, rami subsimilar, endopod shorter. Fifth leg absent.

*Length.*—3.9 mm.

*Host.—Trichiurus savala, T haumela.*

*Distribution.*—India (Kerala, Bombay).

Location of type unknown.

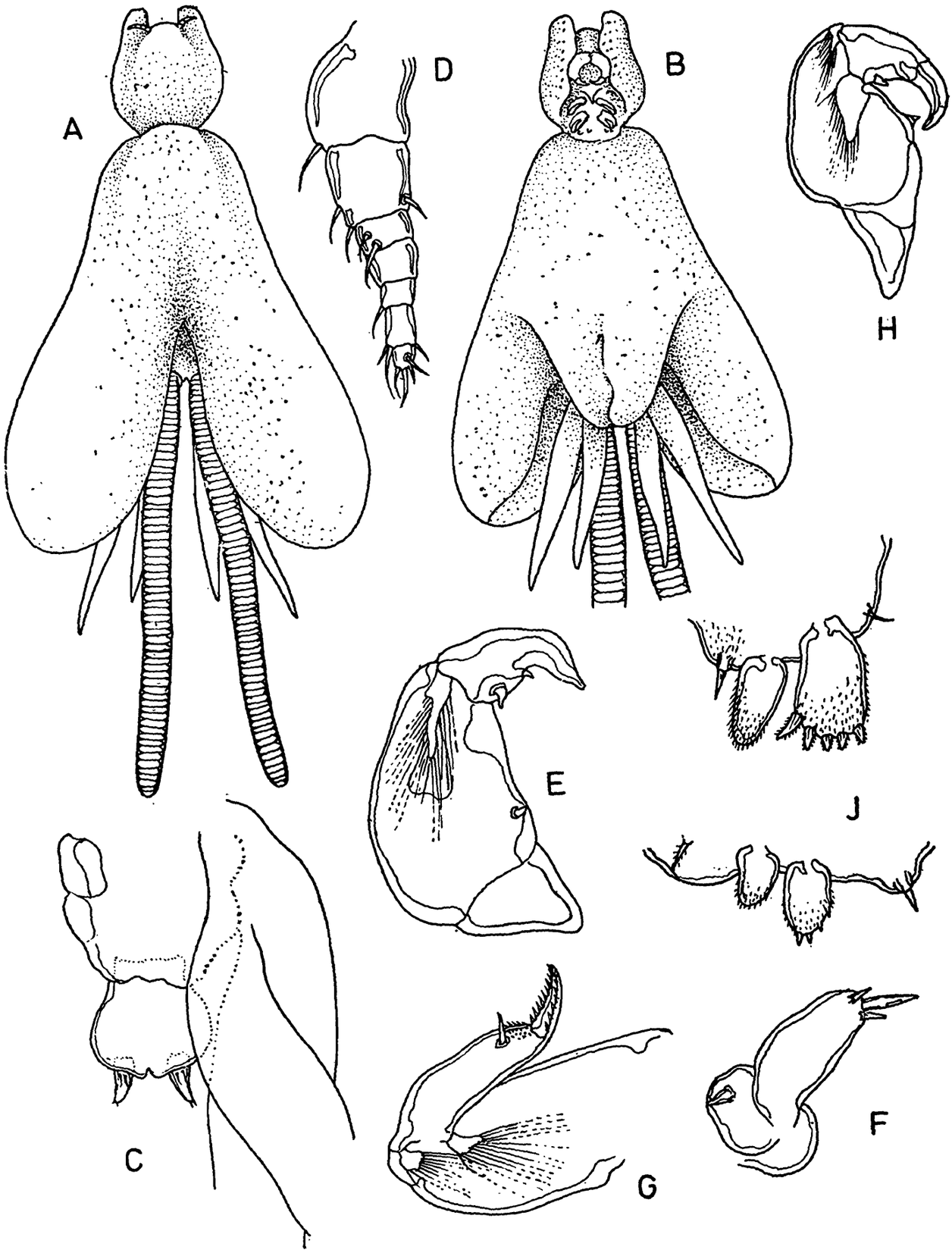


Fig. 185. *Lernanthropus forficatus* Redkar *et al.* : A, female, dorsal view ; B,same, ventral view; C, posterior part of trunk; D, antennule; E, antenna; F, maxillule ; G, maxilla ; H, maxilliped ; I-J, legs 1-2.

*Remarks.*—The original description of this species is very unsatisfactory. According to Redkar et al "the first three segments of the cephalothorax are represented by squares" The "carapace is split into two halves" They have illustrated the dorsal plate as separated from the trunk by a partition. Contrary to Redkar et al the fifth leg is absent. The identity of the present material is however clear.

## **Lernanthropus gibbosus** Pillai
(Fig. 186)

*Lernanthropus gibbosus* Pillai, 1964a, p. 55, fig. 13 ; 1967d, p. 1625, fig. 147.

*Female.*—Cephalothorax comparatively large, nearly equal in length and width. Antero-lateral parts expanded into large oblong lobes projecting forwards as two apically rounded horns. Postero-median part of dorsal side forming a large boss. Anterior division of trunk nearly as long as broad, with large antero-median boss. The dorsal plate large and forked almost down to its base, exposing the hind body. In the lateral view the ventro-lateral parts of the anterior division of trunk produced into a lobe carrying a spinule. Fifth trunk segment large, transversely rectangular. Genital segment large, narrowing backwards. Abdomen proximally narrow. Caudal rami nearly as long as abdomen.

Antennule six-jointed, basal segment large, ventrally spinulose. Antenna stout, distal segment robust, with two proximal processes. Inner lobe of maxillule with one and outer with two spines. Distal segment of maxilla with two spines and a few denticles, unguis with marginal teeth. Maxilliped stout but smaller than antenna.

Legs one and two subsimilar, exopod with five barbed teeth, endopod of first with an apical spine, basipod of second leg without inner and outer spine. Third legs uniramous and separate, narrowing distalwards. Fourth leg biramous, endopod slightly shorter than exopod, exopod basally broad and steadily narrowing. Fifth leg short, with one or two setae.

*Length.*—6.1 mm.

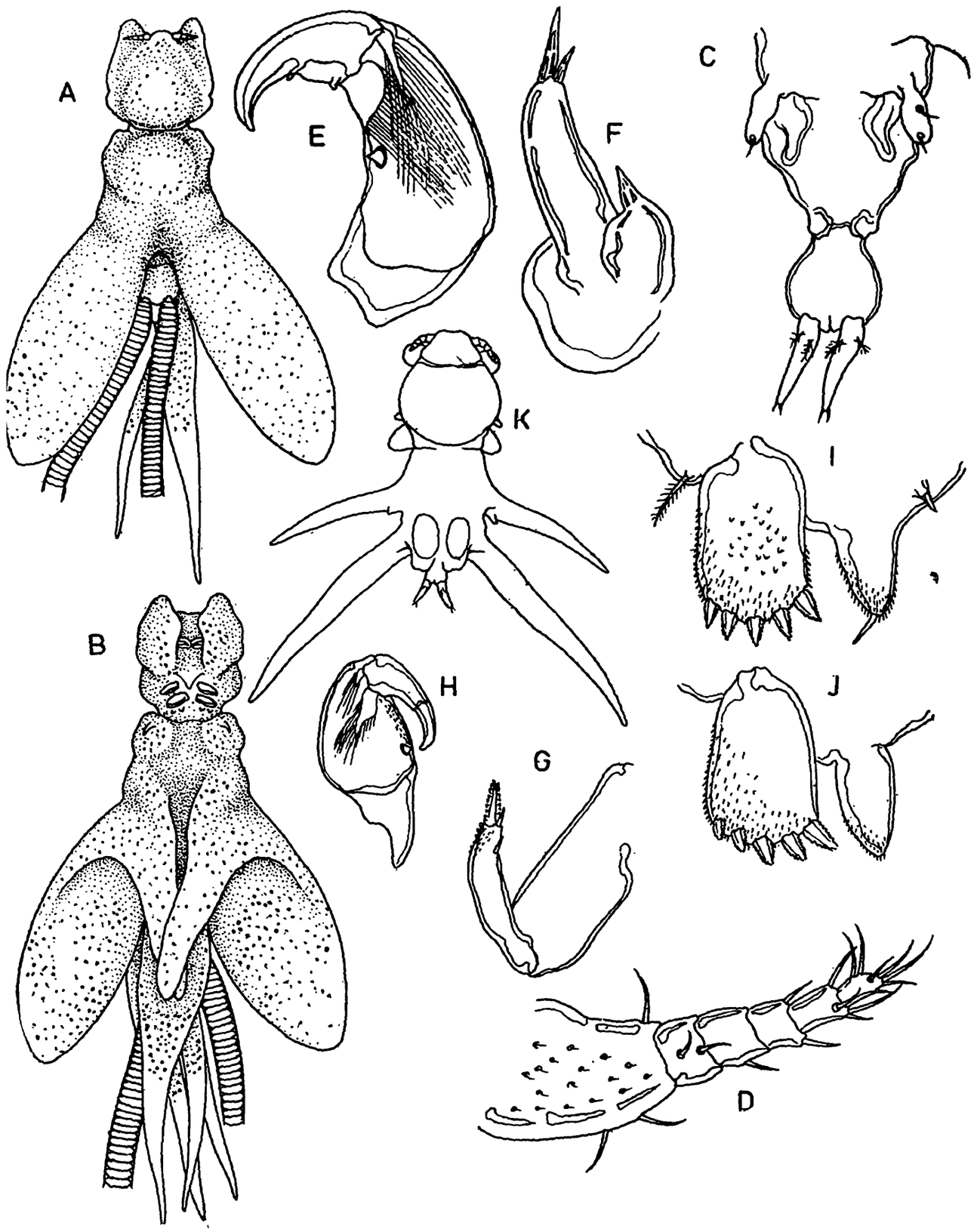


Fig. 186. *Lernanthorpus gibbosus* Pillai : A, female, dorsal view : B, same, ventral view ; C, posterior part of body ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H, maxilliped ; I-J, legs 1-2 ; K, male.

*Male.*—Cephalothorax pyriform, posteriorly evenly rounded and overlapping the trunk. Second thoracic segment small, demarcated by a transverse groove. Rest of the segments, including abdomen fused. Caudal rami long. Third and fourth legs uniramous, former very short. Fifth leg setiform.

*Length.*—1.6 mm.

*Host.*—*Saurida tumbil.*

*Distribution.*—India (Kerala).

*Types* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 4447/1 & C 4448/1.

**Lernanthropus giganteus** Kroyer
(Fig. 187)

*Lernanthropus giganteus* Kroyer, 1963, p. 280, pl. 8, fig. 1 ; Wilson, 1913, p. 227, pl. 33, figs. 148-150 ; Yamaguti, 1863, p. 148, pl. 158, fig. 2 ; Kirtisinghe, 1964, p. 98, figs. 132-137.

*Female.*—Cephalothorax slightly longer than broad, very slightly widening backwards. Antennular lobe broad. Anterolateral lobes small, not projecting beyond the antennular lobe. Anterior division of trunk only slightly broader than cephalothorax, widening backwards, postero-laterally fused with the third legs and drawn out into lobes. Dorsal plates very large and nearly circular. Fourth, fifth and genital segments distinct, subequal in size. Abdomen long, proximally constricted. Caudal rami as long as abdomen.

Antennule rather stout and eight-jointed, basal segment large, distal small. Antenna rather slender, distal segment distally bent at right angles. Inner lobe of maxillule with one and outer with three barbed spines, median spine of outer lobe stout, others small. Distal segment of maxilla very slender, with two patches of denticles and two short processes, unguis with strongly dentate border. Basal segment of maxilliped stout, distal long and slender.

Exopod of first leg rectangular, with five subequal barbed teeth, apical spine of endopod very long and pectinate. Second leg rather

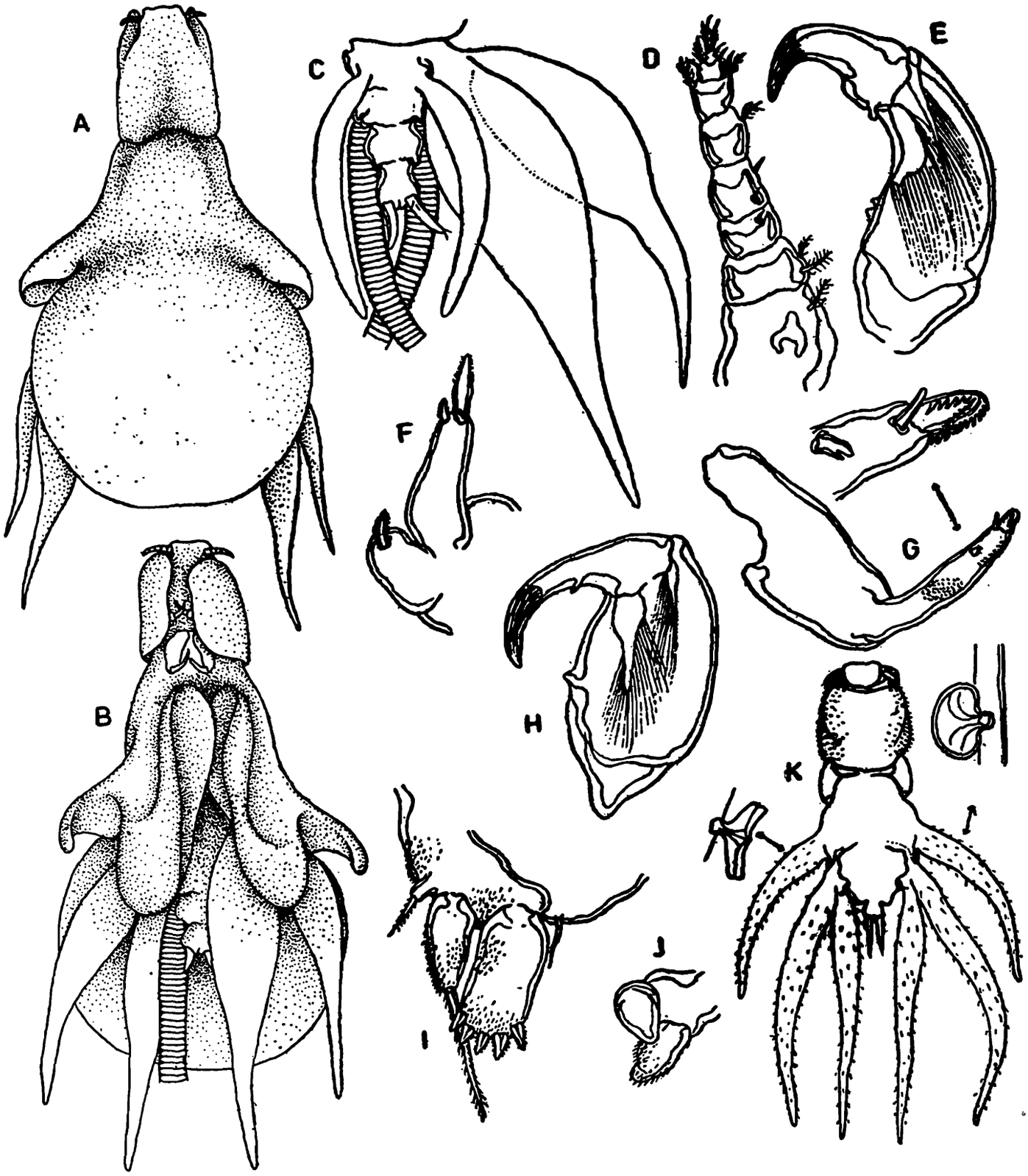


Fig. 187. *Lernanthropus giganteus* Kroyer : A, female, dorsal view ; B, same, ventral view ; C, posterior part of body ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H. maxilliped ; I-J, legs 1-2 ; K, male.

degenerated, with small unarmed rami. Fourth leg biramous, reaching clearly beyond the dorsal plate of trunk, endopod longer than expod, both proximally very broad and distally very narrow. Fifth leg well developed, slender and reaching far beyond the caudal rami.

*Length.*—7.5 mm.

*Male.*—Cephalothorax longer than broad. Antennular lobe very prominent and set off by a prominent groove. Lateral parts of cephalothorax spiny. Trunk segments fully fused, roughly oval in shape. Abdomen distinct. Caudal rami slender and long.

Antennule seven-jointed, armed with spines and setae. Antenna comparatively longer than in female. First leg as in female. Endopod of second leg modified. Third leg biramous, exopod long, endopod very short and triangular. Fourth leg biramous, rami subequal in length. Fifth leg setiform. Cephalothorax and legs three and four armed with button-shaped processes appearing as spinules.

*Length.*—4.2 mm.

*Host.*—*Caranx carangis*, *C. melanampygus*, *C. crysos*, *C. hippos*, *C. senegalensis*, *Carangoides ferdau*.

*Distribution.*—Brazil, Aden, Jamaica, Texas, West Africa, India, Sri Lanka.

*Remarks.*—Wilson's illustration of the female is different from mine in some respects. The postero-lateral lobes of the anterior division of the trunk are actually fused with the third legs and in my specimens the dorsal plate has only a very shallow postero-median concavity. But the males agree very well establishing the identity.

Hewitt observed that a group of species from carangid fishes recorded from the Indian ocean may be referable to *L. giganteus* though they differ in the nature of the fifth leg. It is indeed true that *Lernanthropus* spp. from carangid fishes show great similarity.

It is well established that copepod parasites show great difference in size depending on the size of the host fish. Hence it is quite possible that at least some of the records of *L. giganteus* are wrong.

Much reliance cannot be placed on the accuracy of the descriptions by early workers like Kroyer. Even Wilson has not always provided details. Notwithstanding the differences mentioned above I feel that the present specimens belong to *L. giganteus*. If so this species shows very conspicuous characters. For future comparison both sexes are fully illustrated.

## **Lernanthropus indicus** (Pillai)
(Fig. 188)

*Lernanthropus carangis* Pillai, 1964a, p. 48, fig. 9 (nec Hesse 1878)
*Lernanthropus indicus* Pillai, 1967d, p. 1630, fig. 159.

*Female.*—Cephalothorax slightly longer than broad, antero-lateral lobes projecting far beyond the antennular lobe as apically blunt large triangular processes. Anterior division of trunk broader than long, postero-laterally forming short apically rounded lobes. Dorsal plate as broad as anterior division of trunk, demarcated from the latter by deep narrow incisions, its posterior border very short, with median concavity. Fourth and fifth segments indistinguishable. Genital segment small, squarish. Abdomen only slightly narrower than genital segment, broader than long. Caudal rami nearly as long as abdomen, with two plumose setae and two spines.

Antennule eight-jointed. Antenna rather stout and strong. Inner lobe of maxillule with one spine, outer with two narrow spines and a stout, rather swollen spine. Maxilla rather stout, distal segment with two spines and a patch of denticles, unguis strongly dentate. Maxilliped strong, distal segment short but stout.

Basipod of first leg with inner spine, exopod with five teeth, first rather small, endopod smaller than exopod. Basipod of second leg produced externally into a large conical lobe carrying a semicircular base holding a spine, exopod as large as endopod, with five teeth, three of them small, endopod with a long pectinate spine. Third leg biramous, separate, rami similar, flat laminae. Fourth

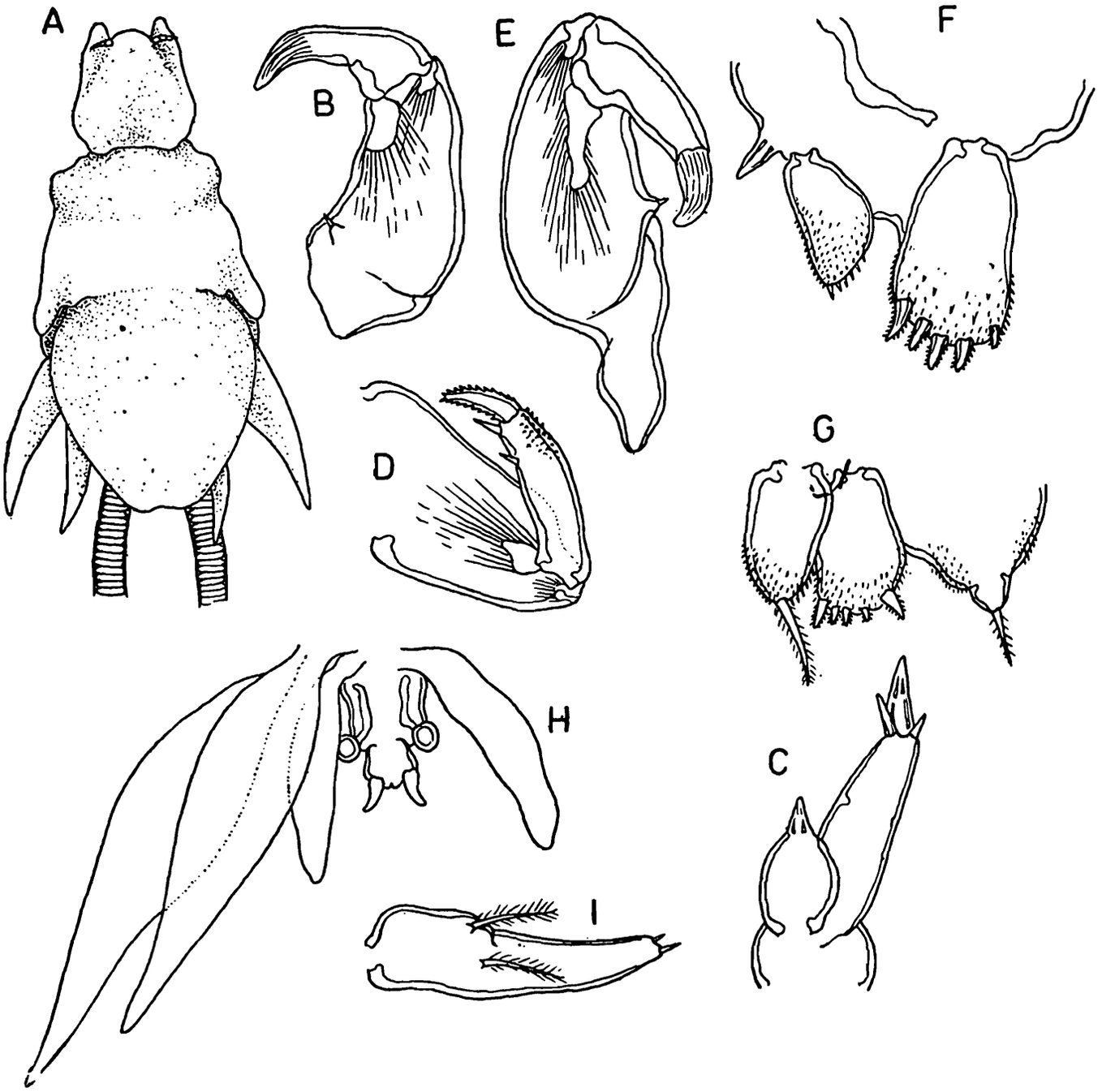


Fig. 188. *Lernanthropus indicus* Pillai : A, female, dorsal view ; B, antenna ; C, maxillule ; D, maxilla ; E, maxilliped ; F-G, legs 1-2 ; H, posterior part of body ; I, caudal ramus.

leg biramous, rami basally broad and strongly narrowing distalwards, only slightly projecting beyond the dorsal plate, endopod slightly shorter than exopod. Fifth leg fairly well developed, uniramous, reaching beyond the caudal rami.

*Length.*—3.6 mm.

*Host.—Caranx sansun.*

*Distribution.*—India (Kerala).

*Type* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 4441/1.

*Remarks.*—Hewitt commenting on this species observed that species of *Lernanthropus* recorded from carangids in the Indian waters are probably synonymous with *L. giganteus* and that a critical study of large collections alone can help in establishing the validity of these species. It is indeed true that this species shows close resemblance to parasites of carangids, such as *L. giganteus* and *L. koenigii*. But *L. indicus* shows distinct difference in the various appendages.

I have in my collection a few species of *Lernanthropus* collected from carangid fishes. They superficially appear very similar except in size. This resemblance appears to be the result of adaptation to the same microhabitat conditions. The same is evident, as pointed out earlier in this report, in the case of caligids parasitic on carangids.

**Lernanthropus koenigii** Stp. & Lutk.
(Fig. 189)

*Lernanthropus koenigii* Stp. & Lutk ; 1861, p. 395, pl. 12, fig. 23 ; Gnanamuthu, 1950g, p. 277, figs. 19-33 ; Yamaguti, 1963, p. 149, pl. 166, fig. 2.

*Female.*—Cephalothorax roughly equal in length and width, postero-laterally bulging and consequently broadest. Antennular lobe half the width of frontal margin. Lateral lobes projecting forwards as small rounded lobes. Anterior division of trunk comparatively very broad, antero-laterally shoulder-like and postero-laterally produced into large apically rounded lobes separated from the dorsal plate by deep incisions. Dorsal plate longer but narrower than anterior division of trunk, nearly equal in length and width, postero-medially concave. Fourth and fifth segments distinct, latter short. Genital segment large, longer than broad. Abdomen partially fused with genital segment. Caudal rami only slightly shorter than abdomen.

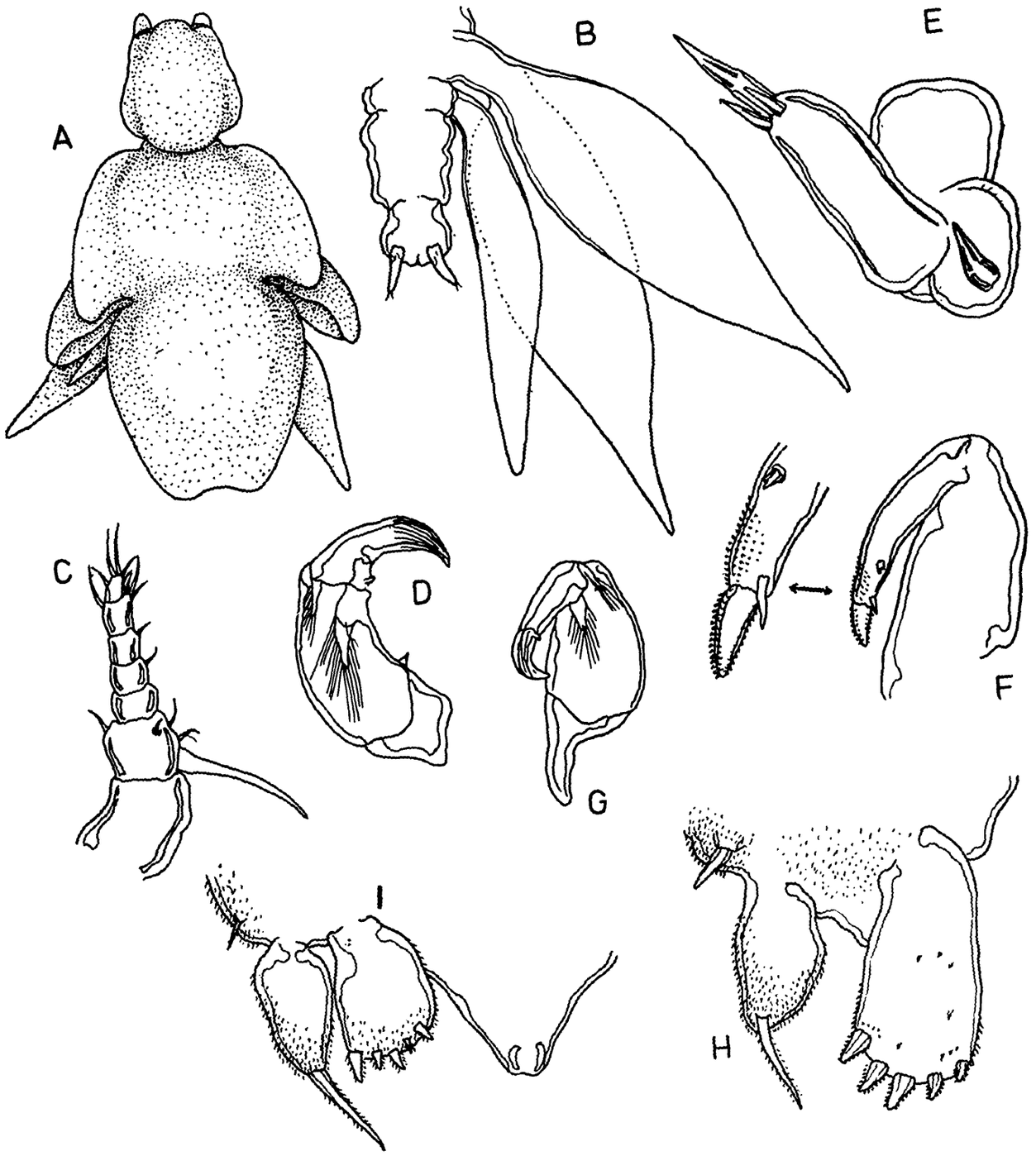


Fig. 189. *Lernanthropus koenigii* Stp. & Lutk. : A, female, dorsal view ; B, posterior part of body ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2.

Antennule seven to eight-segmented, basal segment stout, associated with a spine-like process. Antenna slender but strong,

distal segment comparatively stout. Inner lobe of maxillule with a short but stout spine, outer with three spines, median spine very stout. Distal segment of maxilla distally spiny and with two stout processes, unguis bilaterally dentate. Distal segment of maxilliped apically strongly curved.

Exopod of first leg twice as long as broad, with five stout blunt barbed teeth, endopod fairly large, with a long pectinate spine. Endopod and basipod strongly spinulose. Rami of second leg nearly of the same length, exopod broader, with small teeth, spine on endopod comparatively longer. Third legs fused with the trunk, separate, rami fused and folded lengthwise. Fourth leg with subsimilar comparatively broad rami. Fifth leg large, only slightly shorter than the endopod of fourth leg.

*Length.*—5.3 mm.

*Host.*—*Parastromateus niger*, *Stromateus paru.*

*Distribution.*—Tranquebar, India (Madras, Kerala).

## **Lernanthropus lappaceus** Wilson
## (Fig. 190-191)

*Lernanthropus lappaceus* Wilson, 1912a ; p. 240, pl. 34 ; Tripathi, 1962a, p. 206 fig. 30 ; Yamaguti, 1963, p. 149, pl. 157, fig. 2 ; Pillai, 1966, p. 138, fig. 10.

*Female.*—Cephalothorax slightly longer than broad and broader behind. Antennular lobe not projecting. Antero-lateral lobes well developed. Borders of cephalothorax hairy. Anterior division of trunk nearly circular, demarcated from dorsal plate by a distinct constriction. Dorsal plate large, gradually widening backwards, clearly longer than broad. Fourth, fifth and genital segments completely fused. Abdomen broader than long. Caudal rami very large, proximally broad and steadily narrowing towards the tip.

Antennule seven-segmented, first two segments stout. Antenna comparatively slender but strong, distal segment very stout. Inner lobe of maxillule small, spine stout and flattened, median distal spine of outer lobe large. Maxilla rather feeble, distal segment

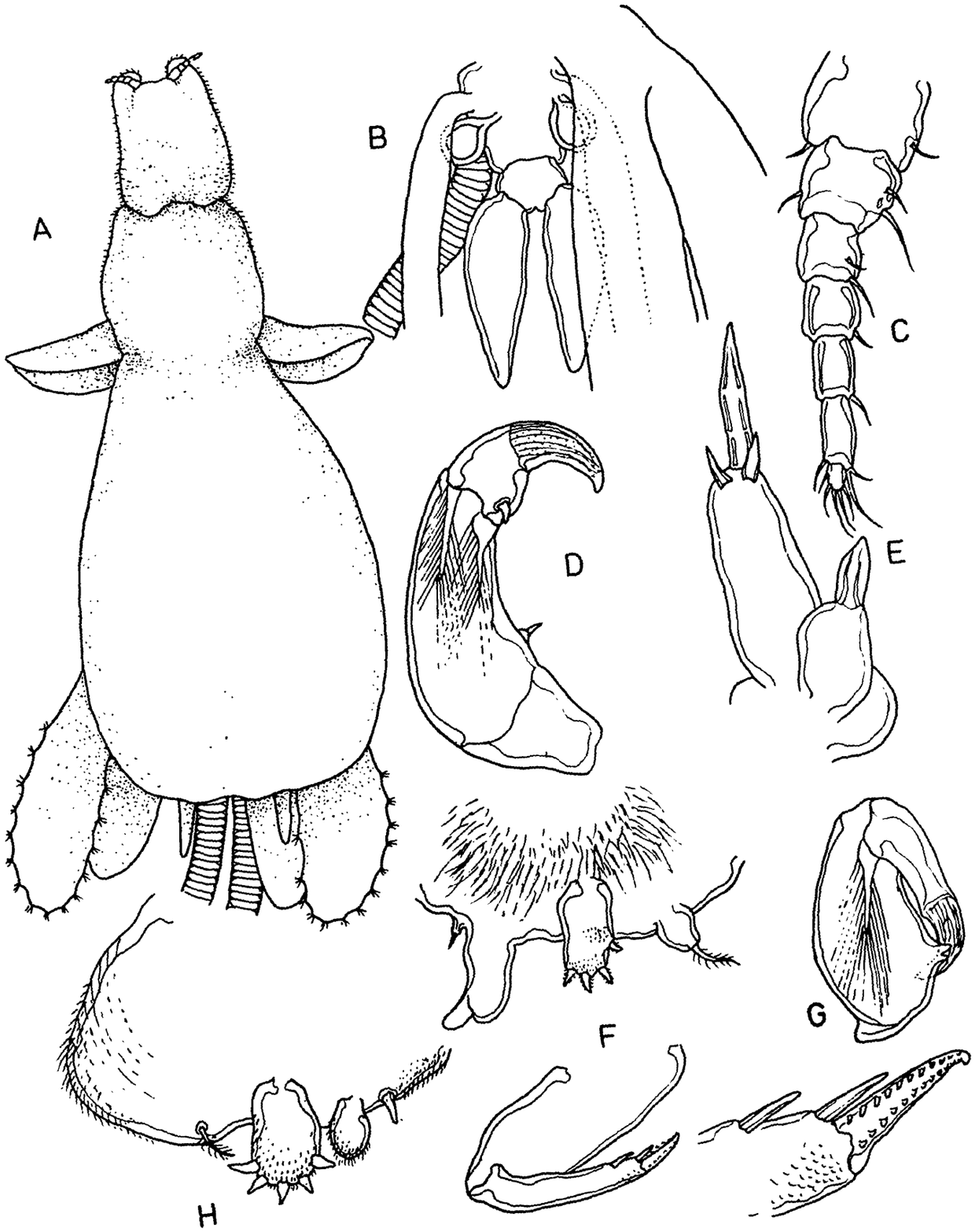


Fig. 190. *Lernanthropus lappaceus* Willson : A, female, dorsal view ; B, posterior part of body ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2.

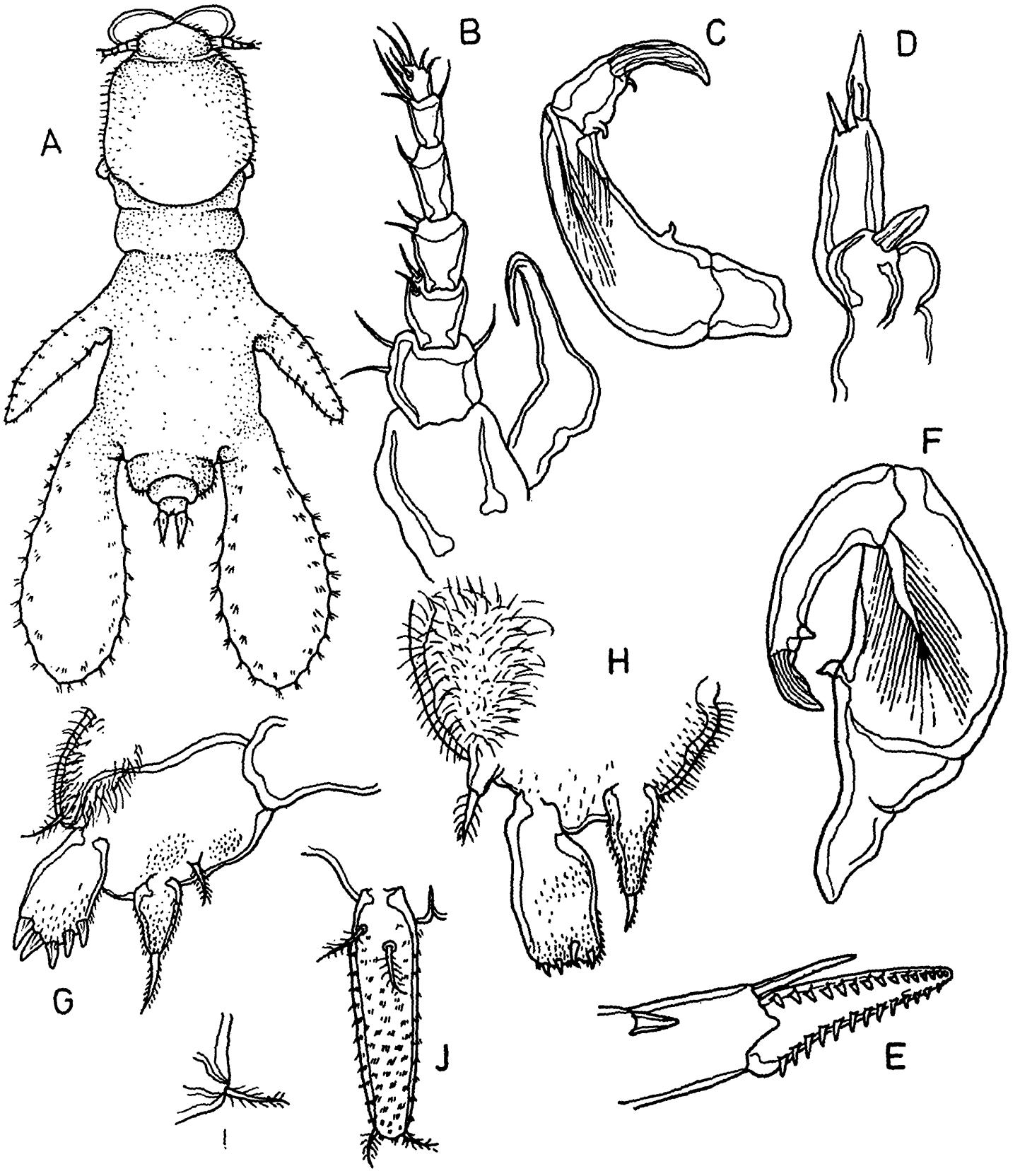


Fig. 191. *Lernanthropus lappaceus* (contd.) : A, male, dorsal view ; B, antennule ; C, antenna ; D, maxillule ; E, maxilla ; F, maxilliped ; G-I, legs 1, 2 and 5 ; J, caudal ramus.

distally feebly spiny and with two long processes, unguis with two rows of stout teeth. Maxilliped smaller than antenna but stout, distal segment nearly as long as basal, apically curved.

Basipod of first leg very large, externally prominently hairy, exopod with five moderately large teeth, endopod small, without spine. Basipod of second leg profusely hairy, exopod with four teeth, endopod unarmed, longer than exopod, outer seta on basipod placed on a stout process. Third leg uniramous and small, longitudinally folded. Fourth leg biramous, rami distally expanded and club-shaped, with marginal bunches of spines. Fifth leg well developed, slender, reaching beyond the dorsal plate, not spiny.

*Length.*—8.0 mm.

*Male.*—Cephalothorax slightly longer than broad. Antennular lobe clearly demarcated. First two thoracic segments clearly marked, others fused together. Abdomen short and distinct. Caudal rami slender.

Antennule like that of female but with longer setae and associated with a strong curved process. Antenna comparatively very slender. Maxillule almost like that of female, unguis of maxilla prominently swollen. Maxilliped rather stout, distal segment with an accessory process, unguis somewhat swollen. Exopod of first leg with five stout teeth, endopod with a spine. Second leg larger than first, exopod with one long and four small teeth, endopod with a short spine. Basipod of both legs hairy. Third leg uniramous and shortt with small endopodal lobe. Fourth leg widening, club-shaped, with marginal and submarginal bunches of spines. Fifth leg setiform. Lateral areas of cephalothorax and genital segment spiny. Caudal rami cylindrical, with bunches of spinules.

*Length.*—3.1 mm.

*Host.—Polynemus tetradactylum.*

*Distribution.*—Batavia, India (Orissa, Kerala).

*Remarks.*—The only available complete description of this species is that by Wilson. Tripathi described the male but omitted

the spines on the legs in his figure. Wilson's description is accurate but lacks details which are provided here. Both males and females of this species can be distinguished by the shape and armature of the fourth legs.

*L. lappaceus* occurs along with *L. trifoliatus* on *Eleutheronema tetradactylum*. They show very close similarity, except in the shape of the rami of the fourth leg which are distally expanded in *L. lappaceus*. It appears that *L. trifoliatus* is more common on immature hosts and *L. lappaceus* on large mature individuals. As it is generally found that larger hosts harbour larger parasites it is likely that *L. lappaceus* represents only larger individuals of *L. trifoliatus*.

## **Lernanthropus latis** Yamaguti
(Fig. 192)

*Lernanthropus latis* Yamaguti, 1954, p. 389, pl. 5, figs. 42-48 ; 1963, p. 149 pl. 161, fig. 2 ; Kirtisinghe, 1964, p. 100, fig. 140.

*Lernanthropus latesi* Tripathi, 1962a, p. 192, figs. 1-8.

*Female*.—Cephalothorax longer than broad, roughly rectangular. Antero-lateral lobes rounded, narrower than antennular lobe and not overreaching the latter. Anterior division of trunk nearly twice as long as cephalothorax, broadening backwards. Dorsal plate large, anteriorly narrower than anterior division of trunk but suddenly expanding into a nearly circular lobe. Fourth segment indicated. Fifth fused with genital segment. Abdomen short, partially fused with genital segment. Caudal rami longer than abdomen.

Basal segment of antennule swollen, rest of the appendage slender. Antenna long and strongly built, basal segment with a large tooth, basal part of distal segment broad, distal part rather stout and grooved. Inner lobe of maxillule with one and outer with three spines. Basal segment of maxilliped stout, distal very slender, with two spines.

Exopod of first leg stout, outer claw very stout, second and fourth small, all the claws rather blunt, endopod narrow, with a small apical spine. Inner spine on basipod barbed. Rami of second leg subequal in length, exopod with small teeth, endopod with a long

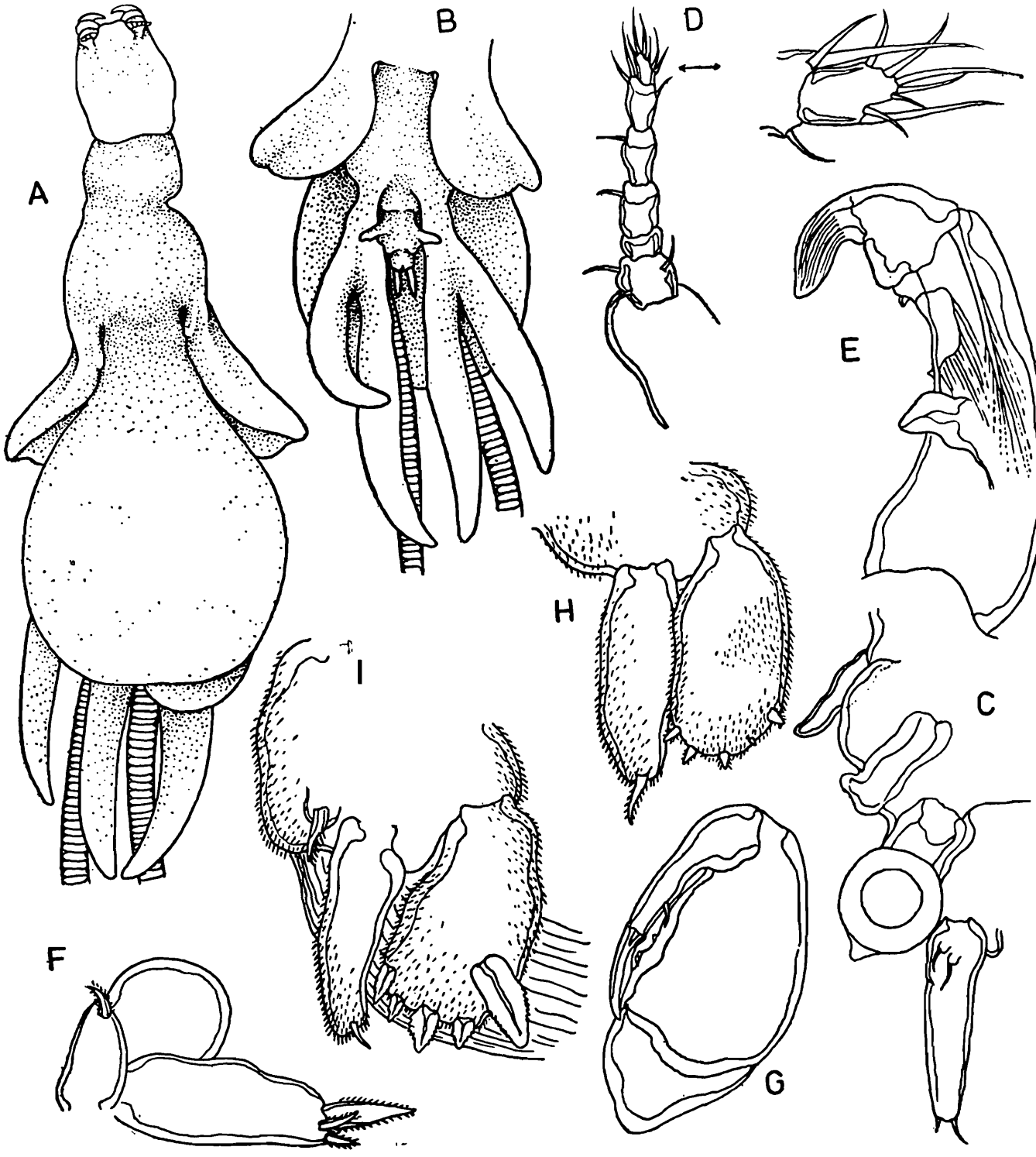


Fig. 192. *Lernanthropus latis* Yamaguti : A, female, dorsal view ; B, posterior part, ventral view ; C, hind part of trunk ; D, antennule ; E, antenna ; F, maxillule ; G, maxilliped ; H, leg 2 ; I, leg 1.

spine. Both legs prominently spinulose. Third legs uniramous, longitudinally folded and fused to the postero-lateral lobes of the anterior division of the trunk. Fourth leg biramous, with distinct

peduncular portion, exopod much shorter than endopod. Fifth leg very small.

*Length.*—7.0 mm.

*Host.*—*Lates calcarifer.*

*Distribution.*—Macassar (Celebes), India (Orissa, Bengal, Kerala), Sri Lanka.

*Remarks.*—This species has several unique characters and the description given by Yamaguti clearly applies to my specimens except for the absence of spines at the tip of the rami of the fourth legs.

Tripathi described specimens collected from *Lates calcarifer* at Orissa and Bengal as *L. latesi.* But they do not show any difference from *L. latis* and obviously Tripathi did not get a chance to consult Yamaguti's publication before sending the paper for publication. Tripathi has illustrated a tongue-like lobe on the ventral side of the anterior division of the trunk, exactly between the third legs. I could not locate this in my specimens nor has Tripathi described it. The unusually long anterior division of the trunk, the stout process on the basal segment of the antenna and the shape of the fourth leg distinguish this species.

### **Lernanthropus lativentris** Heller
(Fig. 193-194)

*Lernanthropus lativentris* Heller, 1868, p. 223, pl. 21, fig. 4, pl. 22, fig. 1 ; Yamaguti, 1963, p. 149, pl. 159, fig. 3.

*Female.*—Cephalothorax comparatively large, with large lateral lobes remaining bent downwards in fresh specimens but almost horizontal in preserved ones. Median part rather elevated. Antennular lobe faintly demarcated. Anterior division of trunk comparatively narrow, demarcated into three indistinct segments successively broadening backwards. Dorsal plate comparatively very large, as long as broad and irregularly circular, with postero-median concavity. The dorsal surface of body prominently pustulose.

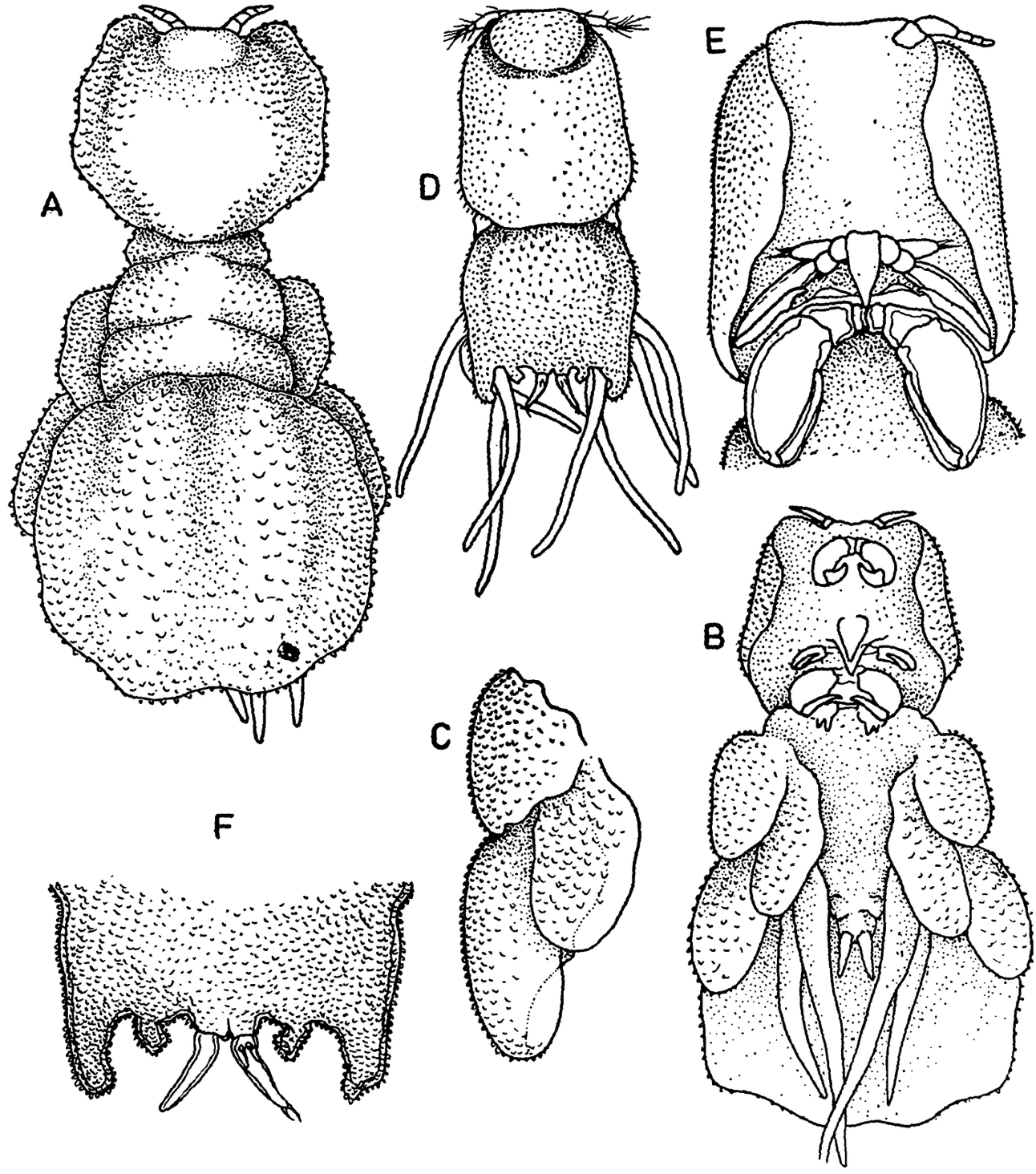


Fig. 193. *Lernanthropus lativentris* Heller : A-C, Female. A, female, dorsal view ; B, same, ventral view ; C, third leg. D-F, Male. D, male, dorsal view ;E, anterior part of body, ventral view ; F, posterior part of body, dorsal view.

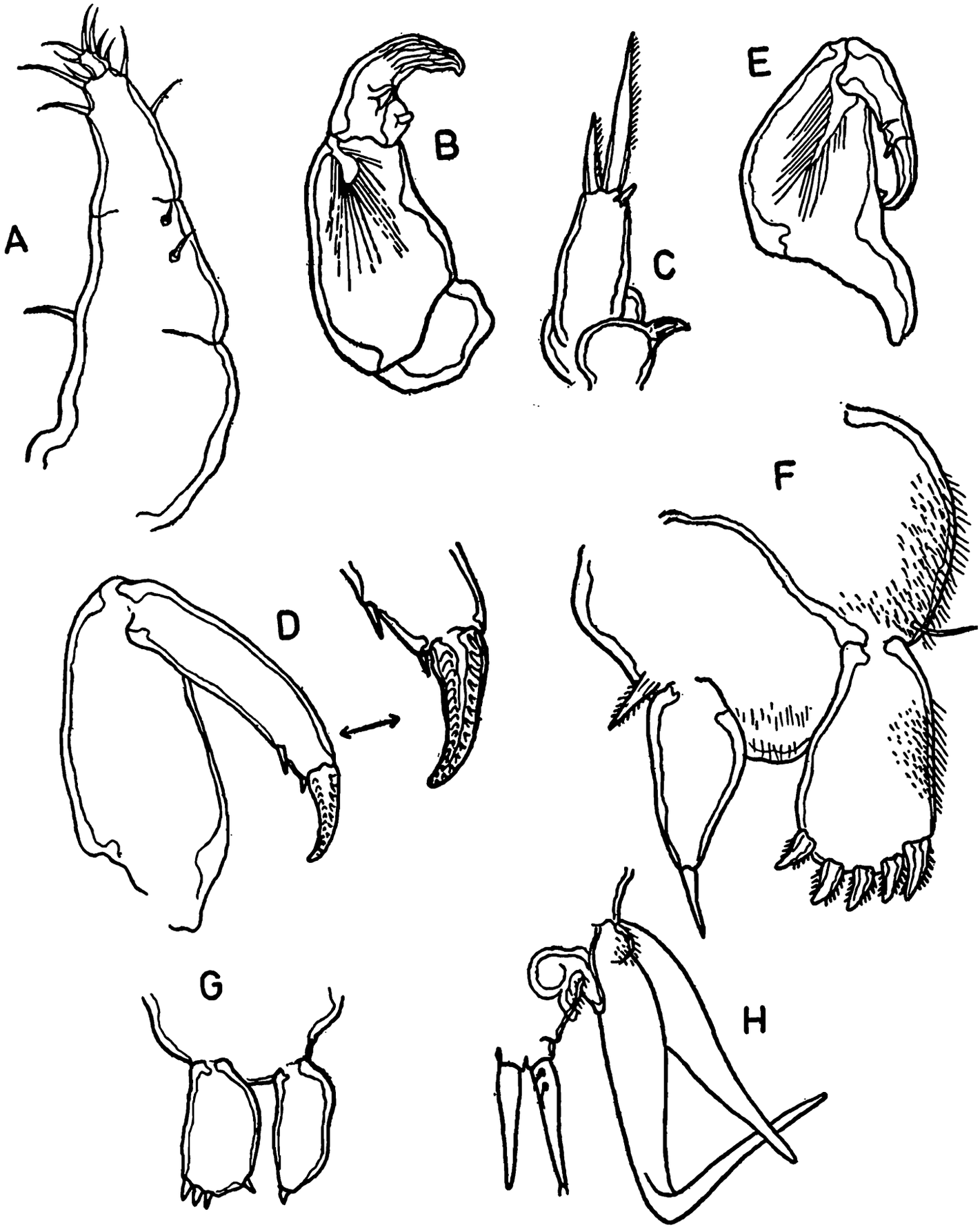


Fig. 194. *Lernanthropus lativentris* (contd.) : Female : A, antennule ; B, antenna; C, maxillule ; D, maxilla ; E, maxilliped ; F-G, legs 1-2 ; H, posterior part of body.

Antennule comparatively large, apparently four-jointed, segmentation very indistinct, distal segment very small. Antenna slender but strongly built, distal segment fairly stout and basally swollen. Inner lobe of maxillule with a conical process, outer with three spines, one very small, others stout and pectinate. Distal segment of maxilla comparatively stout, as long as basal segment, with two short spines, unguis bilaterally dentate. Basal segment of maxilliped somewhat irregular, distal slender, distally well curved.

Basipod of first leg externally and medially hirsute, with outer seta and inner spine. Exopod large and externally hirsute, with five stout, finely barbed teeth, endopod with apical short spine. Second leg comparatively very small, exopod with four small teeth, endopod with one. Third leg typically biramous, protopod projecting on either side of the anterior division of trunk as lobes stopping behind the hind border of the first free trunk segment. Exopod longer than endopod and apparently folded, exposed surface of the legs pustulose. Fourth leg as in *Lernanthropus*, long and slender, endopod much longer than exopod. Fifth leg represented by an irregular lobe. Caudal rami long and slender, with two proximal and two distal slender setae.

*Length.*—3.0 mm.

*Male.*—Body demarcated into cephalothorax and trunk by a distinct transverse suture, former one and a half times as long as latter. Dorsal surface of body prominently pustulose, pustules mostly modified into spines. Antennular lobe large, well delimited and immersed in the cephalothorax. Unlike as in the male of *Lernanthropus* the lateral parts of cephalothorax folded downwards as spiny lobes. Trunk somewhat squarish, postero-laterally prolonged into two apically incurving lobes, with a smaller pair of similar lobes just inside. Abdomen fused with trunk, slightly projecting and distally bilobed. Caudal rami large, with two proximal and two distal setae.

Antennule distinctly five-jointed and setose. Antennae missing. Maxilla and maxilliped comparatively large. First two pairs of legs as in female. Third and fourth pairs subsimilar, biramous, rami

long, slender and nearly of the same width throughout. Fifth leg not observed.

*Length.*—1.0 mm.

*Host.—Lethrinus rhodopterus, Mesoprion phaeotaeniatus.*

*Distribution.*—Indian Ocean, India (Kerala).

*Remarks.*—In spite of some variations in the shape of the body of both sexes I am inclined to refer my specimens to Heller's species. The general shape is the same. But Heller failed to correctly depict the shape of the third leg of the female and he has illustrated the third and fourth legs of the male as shorter, broader and narrowing distalwards, These can certainly be considered as due to error of observation. In the male I could not observe the antennae. In Heller's figure of the male the antennae are missing. Presumably in both cases the antennae got severed while detaching the specimen from the gills. The antennae are the main prehensile organs of the male. Hence there is no possibility to believe that this appendage is lacking in this species.

*L. lativentris* is of particular significance as its third leg clearly proves that the lateral wings of the anterior division of the trunk in *Aethon* and *Norion* are indeed the enlarged protopods of the third legs. This species possesses a combination of the characters of *Lernanthropus*, *Aethon* and *Sagum*. The male very closely resembles that of *Sagum*.

## **Lernanthropus leiognathi** Tripathi
(Fig. 195)

*Lernanthropus leiognathi* Tripathi, 1962a, p. 203, fig. 27.

*Female.*—Cephalothorax comparatively large, broader than long and narrowing backwards. Antennular lobe slightly projecting beyond the lateral lobes. Anterior division of trunk much broader than cephalothorax, antero-laterally rounded, exactly like the dorsal plate and demarcated from the latter by a distinct constriction. Dorsal plate only partially covering the abdomen. Fourth

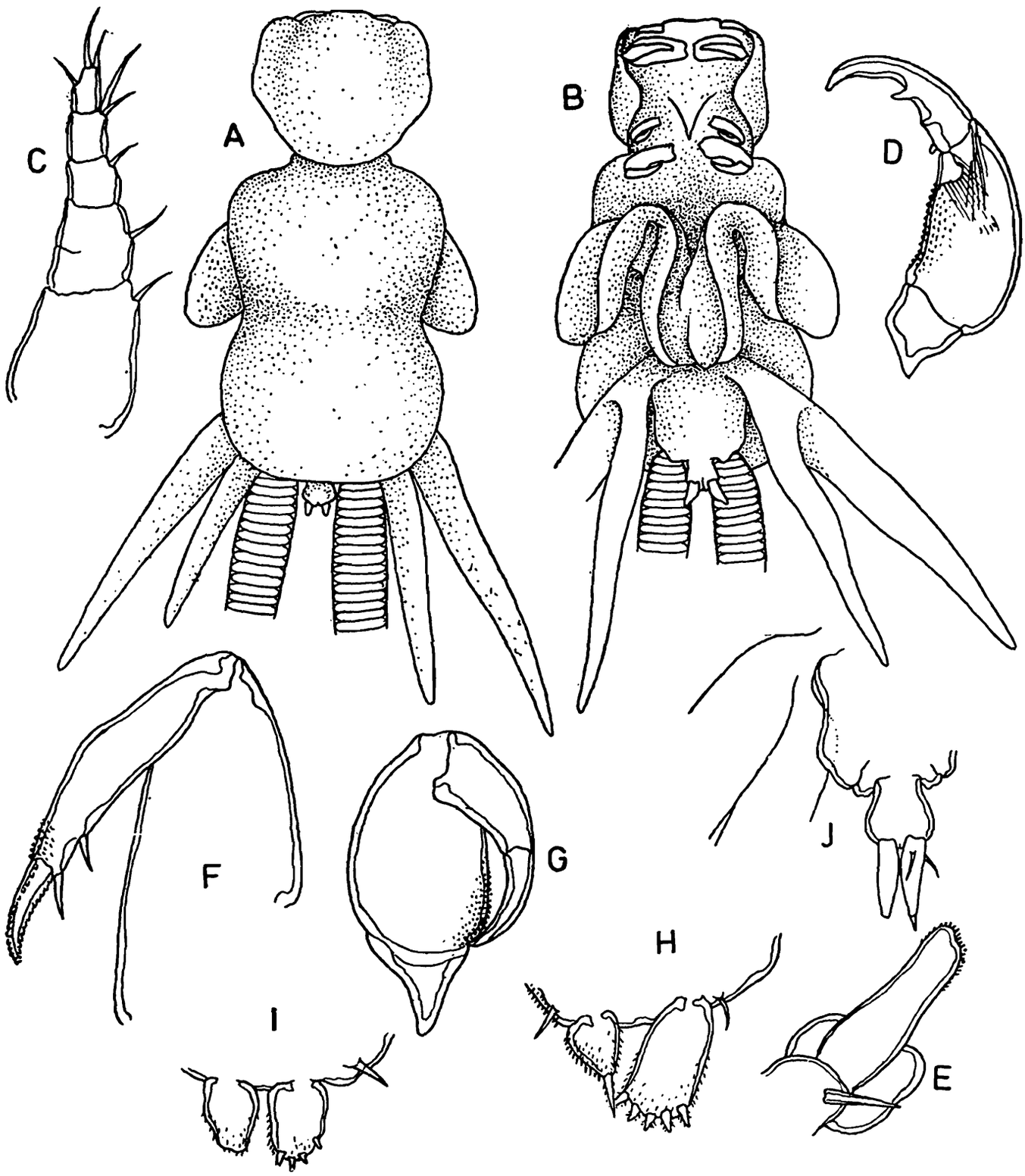


Fig. 195. *Lernanthropus leiognathi* Tripathi : A, female, dorsal view ; B, same, ventral view ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2 ; J, posterior part of body.

segment indistinct. Fifth and genital segments fused, forming a roughly squarish large segment. Abdomen slightly longer than

broad, caudal rami large, longer than abdomen, each with two proximal setae and a distal spine. Egg tubes stout.

Antennule with indistinct segmentation, steadily narrowing distalwards and sparsely setose. Antenna slender, inner part of basal segment pustulose, distal segment long and slender, with two accessory processes, distally well curved. Inner lobe of maxillule with one large spine, outer lobe slender, with the apex pustulose but no spine observed. Distal segment of maxilla with two sharp spines and a patch of denticles, unguis comparatively long and narrow. Proximal inner part of basal segment of maxilliped pustulose, distal segment as long as basal and strongly curved.

Basipod of first leg with inner and outer setae, exopod rectangular, with five subsimilar teeth, endopod small, with an apical spine. Basipod of second leg with outer spine, rami subsimilar, exopod with four small teeth. Third legs biramous, endopods fused into a linguiform lobe with curled edges. Endopod of fourth leg shorter than exopod. Fifth leg absent.

*Length.*—1.3 mm.

*Host.—Leiognathus ruconius, L. daura.*

*Distribution.*—India (Madras, Kerala).

*Remarks.*—The original description of this species by Tripathi contains no details of the appendages. According to him the thorax is long with rounded posterior end and the dorsal plate is constricted in the middle and covers the abdomen. This description is partly misleading and partly incorrect. The dorsal plate does not completely cover the abdomen.

In the armature of the antenna and the maxilliped this species shows some resemblance to *L. secutoris* Pillai.

### **Lernanthropus nemipteri** Jayasree and Pillai
(Fig. 196)

*Lernanthropus nemipteri* Jayasree and Pillai, 1976, p. 21, fig. 1-9.

*Female.*—Cephalothorax nearly rounded, slightly longer than broad, with prominent grooves demarcating it into median and

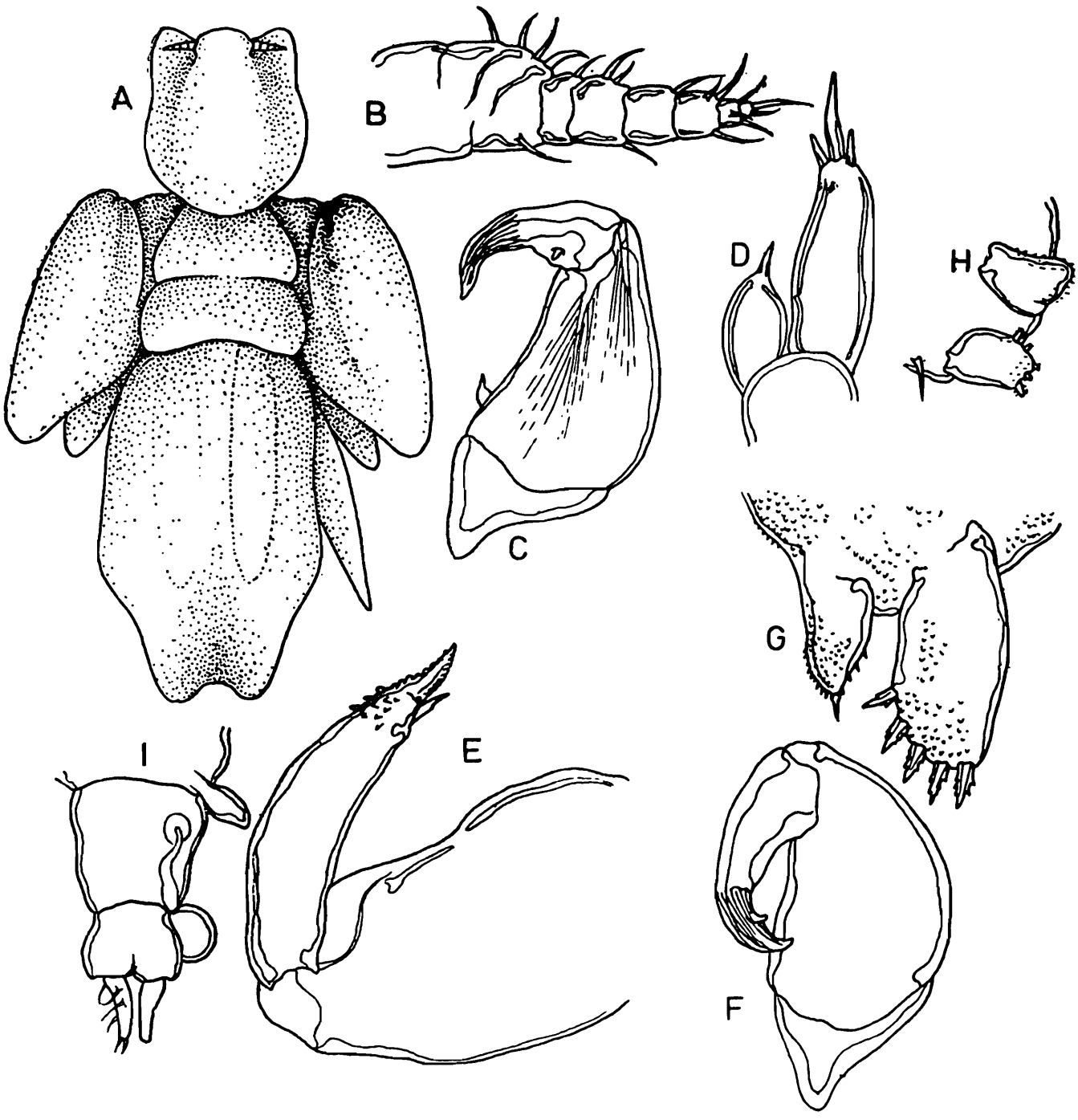


Fig. 196 *Lernanthropus nemipteri* Jayasree and Pillai : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxillule ; E, maxilla ; F, maxilliped ; G-H, legs 1-2 ; I, posterior part of trunk.

lateral areas. Antennular lobe distinct. Antero-lateral parts produced into rounded lobes making the frontal area trilobed. Anterior division of trunk much enlarged, demarcated into two segments, with large wing-like lateral lobes anteriorly rounded and posteriorly angular. Dorsal plate as long as the body in front, suddenly

narrowed at the distal third, distal border bilobed. Fifth, genital and abdominal segments distinct. Caudal rami much longer than broad, each with six short setae. Egg tubes very short, not reaching the distal border of dorsal plate.

Antennule short but stout, eight-segmented, second segment with a hook-like process. Basal segment of antenna with inner spine, distal segment distally grooved. Inner lobe of maxillule with one and outer with three spines. Basal segment of maxilla very large, distal segment narrowing, unguis rather indistinct, distal part of the segment with a few tubercles and a long slender spine, unguis with two rows of tubercles. Basal segment of maxilliped stout, distal segment with an accessory process.

Basipod of first leg sparsely spiny, exopod with five subsimilar sparsely barbed strong teeth, endopod with apical spinule, both rami spiny. Basipod of second leg with an outer seta, exopod with five small teeth, endopod broader than exopod, Third leg biramous, exopod folded lengthwise, endopods overlapping, protopods enlarged into large elytra-like lobes partially fused with trunk and extending forwards as far as the hind border of the cephalothorax. Fourth leg biramous, flattened, only two thirds the length of the dorsal plate, exopod longer than endopod. Fifth leg a small lobe.

*Length.*—3.6 mm.

*Host.*—*Nemipterus furcosus.*

*Distribution.*—India (Kerala)

*Holotype.*—Female in the National Zoological Collection at Zoological survey of India, Calcutta.

*Remarks.*—As already indicated this species shows affinity to *Aethon* in the segmentation of the anterior division of the trunk and in the prolongation of the protopods of the third pair of legs as lateral wings. The dorsal plate is also remotely like that of *Aethon* and quite unlike that of *Lernanthropus*. But the fourth legs and egg tubes are like those of *Lernanthropus*. The characters of this species are such that it can go under *Lernanthropus* as well as *Aethon*. In many ways *L. nemipteri* bridges the gap between these two genera.

## **Lernanthropus nudus** Bassett-Smith
(Fig. 197)

*Lernanthropus nudus* Bassett-Smith, 1898, p. 368, pl. 12, figs. 2-3 ; Tripathi, 1962a, p. 207, 216 ; Yamaguti, 1963, p. 150.

*Host.*—*Mugil* sp.

*Distribution.*—Persian Gulf.

*Remarks.*—The original description of this species, the only one so far available, is such that one cannot get a clear knowledge of its characters. The most characteristic features are the demarcation of the body into three subequal divisions, the postero-median incision of the dorsal plate exposing the genital segment and abdomen and the great length of the fourth legs. The description of the appendages is not at all accurate but a close comparison shows that they generally resemble the appendages of *L. shishidoi* Shiino. I strongly feel that *L. nudus* is a synonym of *L. shishidoi.*

## **Lernanthropus oblongus** Pillai
(Fig. 198)

*Lernanthropus oblongus* Pillai, 1964a, p. 52, fig. 11 ; 1967d, p. 1631, fig. 163.

*Female.*—Cephalothorax longer than broad, antero-medially produced, antero-laterally with a pair of nearly circular pads on the ventral side with a semicircular row of spines. Lateral parts not bent downwards. Anterior division of trunk nearly equal in length and width, in fresh specimens continued as the dorsal plate. In preserved specimens a distinct constriction demarcates them. Trunk antero-laterally angular. Hind border of dorsal plate rounded. Fourth, fifth and genital segments only indistinctly demarcated. Abdomen nearly rounded. Caudal rami small.

Antennule seven-jointed, sparsely setose. Basal segment of antenna stout and triangular, with large spine-tipped process, distal segment exceptionally long. Inner lobe of maxillule with one and outer with three comparatively short spines. Basal segment of maxilla very stout, unguis of distal segment large, with two rows of spines. Maxilliped strongly built, distal segment distally well curved, producing a characteristic shape.

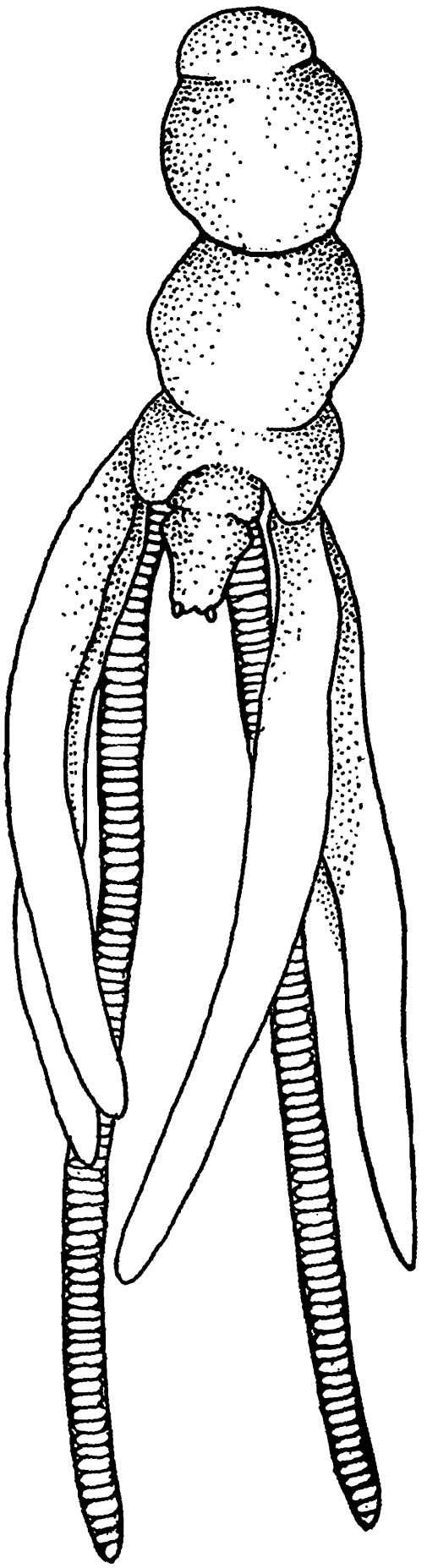

Fig. 197. *Lernanthropus nudus* Bassett-Smith : Female, dorsal view.

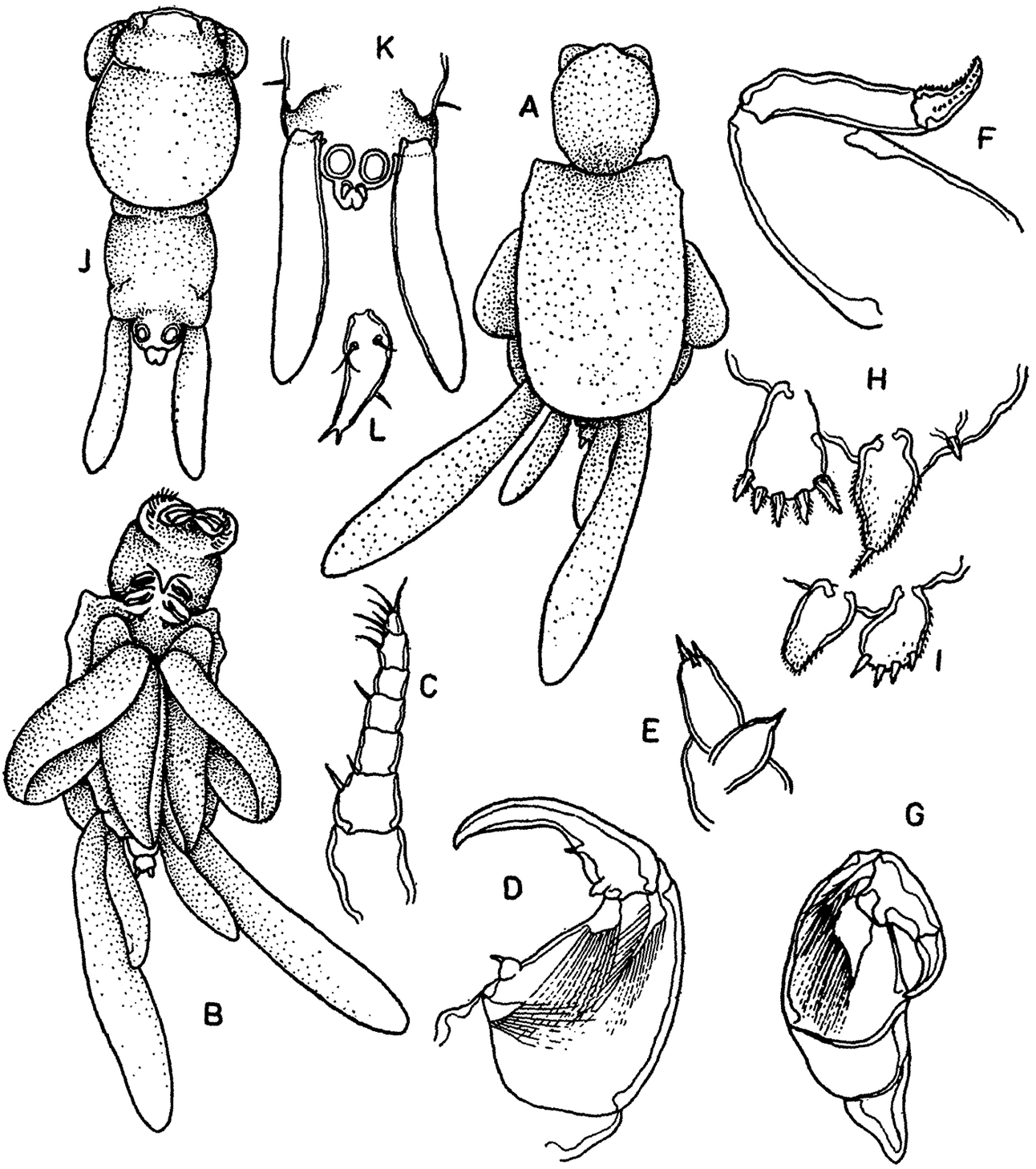


Fig. 198. *Lernanthropus oblongus* Pillai : A-I, Female. A, female, dorsal view ; B, same, ventral view ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2. J-L, Male. J, male, dorsal view; K, same, posterior part of body ; L, caudal ramus.

Exopod of first leg with five large teeth, endopod with a small apical spine. Exopod of second leg with four slender teeth, endopod as large as exopod, without apical spine. Third legs large and biramous, rami subsimilar and folded longitudinally. Fourth legs very characteristic, nearly as long as the body and reaching far beyond the dorsal plate, endopod less than half the length of exopod, latter broadening distalwards. Fifth leg absent.

*Length.*—2.3 mm.

*Male.*—Cephalothorax large and pyriform. Antennular lobe large and clearly demarcated. Trunk demarcated into three segments, first very short. Third legs represented by small ventrally situated lobes carrying a seta projecting outwards. Fourth leg large, placed far back at the base of the genital segment. Latter semicircular. Caudal rami originating from the ventral side of the abdomen and fully hidden in the dorsal view.

*Length.*—0.6 mm.

*Host.—Sardinella fimbriata.*

*Distribution.*—India (Kerala).

*Holotype Female and Allotype* in the National Zoological Collection at the Zoological Survey of India, Calcutta. Reg. No. C 4444/1 & C 4445/1.

*Remarks.*—This species can be easily distinguished by the shape of the body, the presence of a row of spines on the antero-lateral lobes of the cephalothorax and the shape and size of the fourth legs. The male has a very characteristic shape with unusually large cephalothorax. The highly reduced third legs are also characteristic.

From *Chatoessus nasus* Redkar et al. described *L. rubiginosus* which shows very close similarity to *L. oblongus*. From published information on this species *L. rubiginosus* differs in the size of the rami of the fourth legs of the female. Without examining specimens I do not wish to express any definite opinion though there is very little doubt that *L. oblongus* is a synonym of *L. rubiginosus*.

## **Lernanthropus opisthopteri** Pillai
## (Fig. 199)

*Lernanthropus opisthopteri* Pillai, 1964a, p. 54, fig. 12 ; 1967d, p. 1625, fig. 146.

*Female.*—Cephalothorax nearly as long as broad, narrowing backwards and clearly overlapping trunk, anterior border clearly trilobed. Anterior division of trunk broader than long, antero-laterally shoulder-like. Dorsal plate very large, irregularly circular and much longer and broader than anterior division of trunk. Fourth and fifth trunk segments indistinct, genital segment large, nearly as long as broad, abdomen as long as broad, caudal rami longer than abdomen, with two proximal and one outer distal setae and two distal spines. Egg tubes moderately long.

Antennule comparatively small, seven-jointed and normally setose, steadily narrowing distalwards. Basal segment of antenna with a tubercle bearing a spine, distal segment fairly long and stout, with a proximal and a median spine. Inner lobe of maxillule fairly large, with one spine, outer slender, with three spines. Basal segment of maxilla stout, distal segment much shorter than basal, with two short spines and a patch of denticles, unguis bilaterally dentate. Distal segment of maxilliped strongly curved, with two slender sharp spines, unguis long and clearly demarcated.

Basipod of first leg with outer seta and inner spine. Exopod rectangular, with five subsimilar barbed teeth, exdopod smaller than exopod, triangular, with short slender apical spine. Rami of second leg subequal, endopod broader, without apical spine, exopod with five small spines, one of them very small. Outer seta on basipod mounted on a tubercle. Third leg biramous, exopod fused with trunk, endopods partially fused, basipodal part projecting as a longitudinally folded lobe. Fourth leg long and slender, longer than body, rami steadily narrowing, exopod much longer than endopod. Fifth leg a small lobe carrying a seta.

*Length.*—2.1 mm.

*Host.—Opisthopterus tardoore.*

*Distribution.*—India (Kerala).

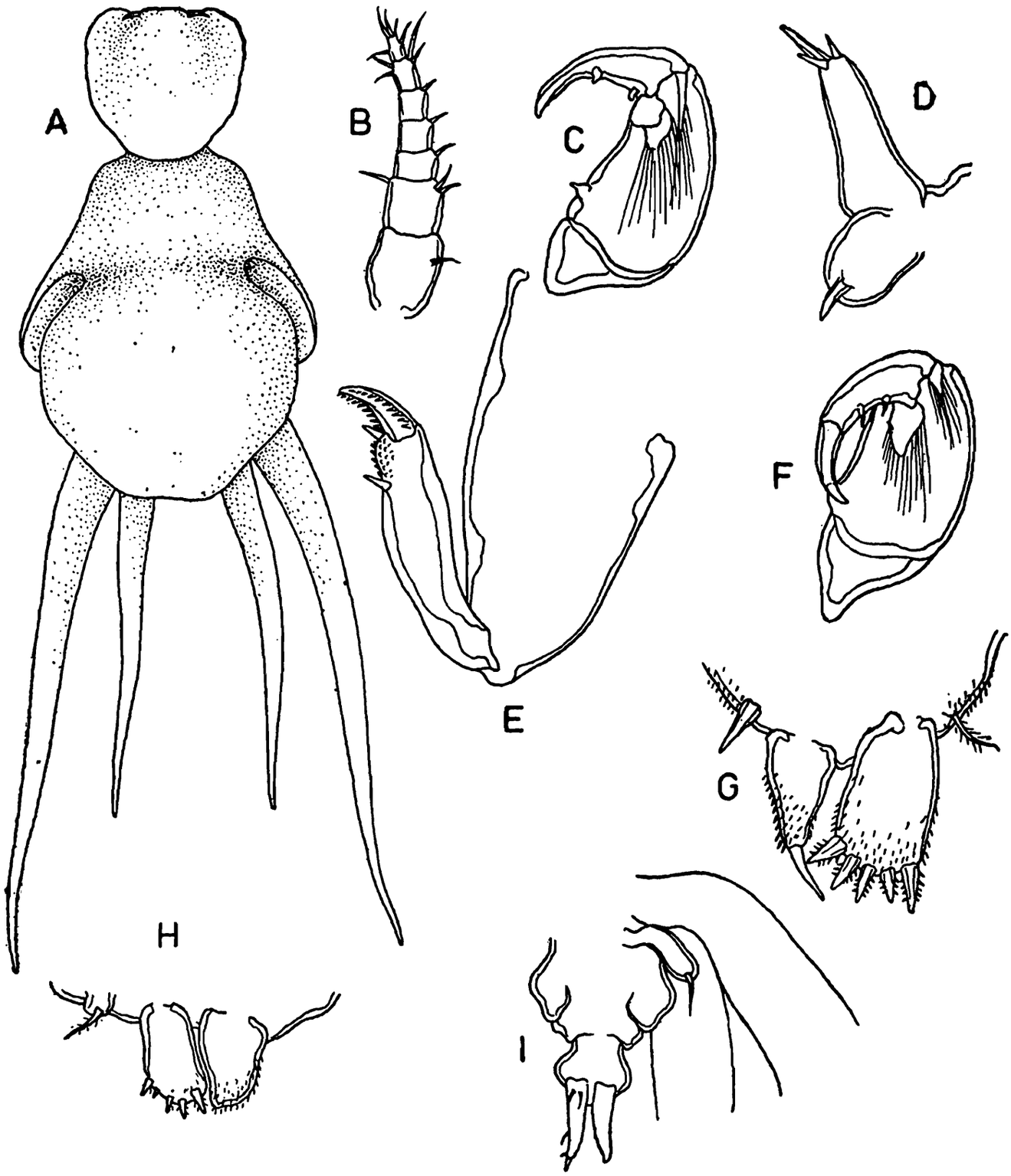


Fig. 199. *Lernanthropus opisthopteri* Pillai : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxillule ; E, maxilla ; F, maxilliped ; G-H, legs 1-2 ; I, posterior part of trunk.

*Type* in the National Zoological Collection at the Zoological Survey of India, Calcutta. Reg. No. C 4446/1.

## **Lernanthropus otolithi** Pillai
(Fig. 200)

*Lernanthropus otolithi* Pillai, 1963c, p. 664, fig. 5 ; 1967d, p. 1631, fig. 165.

*Female.*—Cephalothorax fairly large, narrowing backwards, anterior border prominently trilobed. Antennular lobe projecting beyond the lateral lobes. Anterior division of trunk long and subcylindrical, demarcated from dorsal plate by a slight constriction. Dorsal plate nearly circular. Fourth and fifth segments indistinctly demarcated. Genital segment of average size. Abdomen short but distinct. Caudal rami long, narrowing towards the tip.

Antennule eight-jointed, first three segments swollen. Basa segment of antenna very stout, distal basally swollen, only moderately curved. Inner lobe of maxillule with a short spine, outer lobe long, with three spines, middle spine stout. Distal segment of maxilla slender and distally well curved, with two spines, unguis curved, with strongly dentate margin. Maxilliped robust, proximal part of distal segment swollen, with two spines.

Outer part of basipod of first leg with stiff hairs, exopod with comparatively small acute and barbed teeth, endopod with short apical spine, inner seta on basipod with stout pectinate basal part. Rami of second leg subequal in size, exopod with five very small teeth, endopod with very small apical spine. Third legs uniramous, separate, longitudinally folded. Fourth leg slender and long, reaching far beyond the dorsal plate, endopod only slightly shorter than exopod. Fifth leg normal, about a third of the length of the fourth leg.

*Length.*—3.0 mm.

*Host.*—*Otolithus argenteus, O. maculatus.*

*Distribution.*—India (Kerala).

*Type* in the National Zoological Collection at the Zoological Survey of India, Calcutta. Reg. No. C 4344/1.

## **Lernanthropus pami** Tripathi

*Lernanthropus pami* Tripathi, 1962, p. 199, fig. 22-23.

*Female.*—Cephalothorax nearly equal in length and width, anterior division of trunk subcylindrical, nearly equal in length

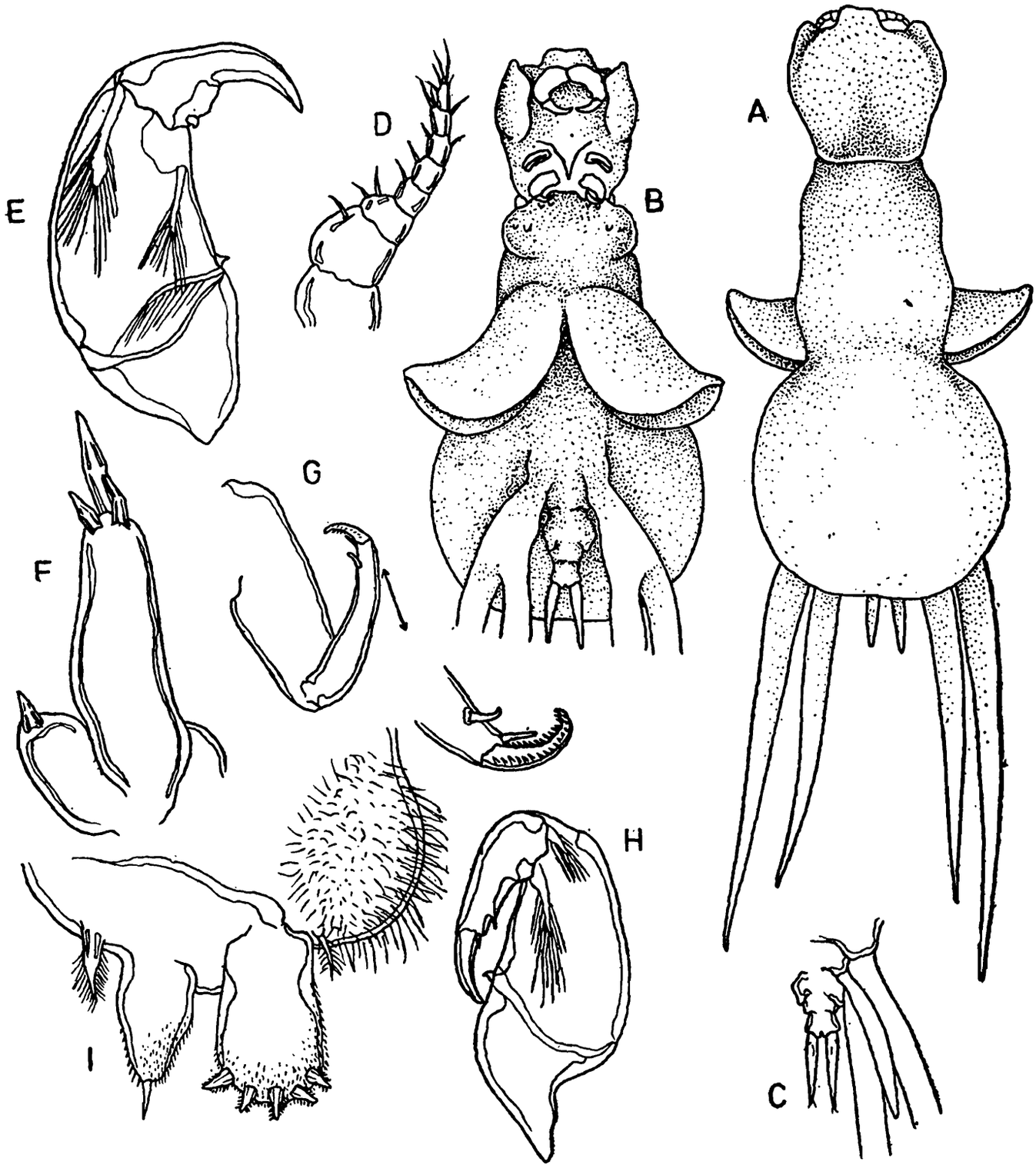


Fig. 200. *Lernanthropus otolithi* Pillai : A, female, dorsal view ; B, same, ventral view ; C, posterior part of trunk ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H, maxilliped ; I, leg 1

and width, dorsal plate not clearly demarcated from anterior division of trunk, only slightly broader than the latter and distally perfectly rounded. Fourth and fifth segments fused with genital

segment to form a large segment. Abdomen small, much narrower than genital segment. Caudal rami reaching the tip of the dorsal plate, without armature.

Antennule seven jointed, associated with a curved process. Antenna fairly large. Maxilliped much smaller than antennae. Third legs small, uniramous, folded lengthwise. Fourth leg biramous, rami subsimilar, overreaching dorsal plate. Fifth leg well developed.

*Length.*—2.26 mm.

*Host.—Pama pama.*

*Distribution.*—India (Hooghly estuary, Diamond Harbour).

*Remarks.*—Tripathi gives only a ventral view of the animal and his description lacks details. A few obvious mistakes should be pointed out. Tripathi says that the basal segment of the antennule carries a flagellum. This so called flagellum is a chitinised process originating near the base of the antennule and not on the antennule. Tripathi describes the rami of legs one and two are setose. This cannot be so. The fourth pair of legs is described as trifoliate and in this character he finds similarity to *L. sciaenae* Gnanamuthu. But the supposed third ramus is really the fifth leg.

### **Lernanthropus pristipomoides** Kirtisinghe

*Lernanthropus pristipomoides* Kirtisinghe, 1937a, p. 450, figs. 99-107 ; 1964, p. 97, figs. 130-131 ; Tripathi, 1962a, p. 207, 216 ; Yamaguti, 1963, p. 151.

*Host.—Pristipomoides typus.*

*Distribution.*—Sri Lanka.

*Remarks.*—This species has not been discovered since Kirtisinghe described it from Ceylon. This is rather surprising since the host is quite common in Indian waters. This species has not been satisfactorily described. The following account is after Kirtisinghe.

Cephalothorax remotely triangular, anteriorly trilobed and postero-laterally projecting far beyond the anterior division of trunk. Latter slightly longer than broad, very narrow in front and separated from the dorsal plate by only a constriction. Dorsal plate transversely oblong. Genital segment short, abdomen shorter than genital segment, caudal rami small. Antennule six-jointed, first segment large and placed at right angles to the rest of the appendage. Antenna comparatively slender. Outer lobe of maxillule with two spines. Maxilla rather slender. Maxilliped slender, basal segment with an inner process, distal with swollen base. Legs one and two of the usual type. Third legs uniramous, longitudinally folded. Fourth leg biramous, with subsimilar rami, not narrowing distalwards.

Cephalothorax of male comparatively very large, roughly semicircular in outline. Trunk demarcated into three parts by constrictions. Third leg biramous, rami subequal in length, not narrowing. Fourth leg with subsimilar, long elliptic rami.

## **Lernanthropus robustus** Pillai
(Fig. 201)

*Lernanthropus robustus* Pillai, 1964a, p. 50, fig. 10 ; 1967d. p. 1627, fig. 148.

*Female.*—Cephalothorax longer than broad, broader behind, hind border deeply concave, anterior border trilobed. Lateral lobes of cephalothorax large and folded vertically downwards. Anterior division of trunk subcylindrical, nearly twice as long as broad. Dorsal plate remotely triangular, longer than anterior division of trunk, posterior border concave and postero-laterally angular. Fourth segment visible, fifth fused with genital segment. Genital segment and abdomen large. Caudal rami as long as abdomen.

Antennule indistinctly eight-jointed and sparsely setose. Antenna slender but strong, distal segment comparatively short but stout. Inner lobe of maxillule with a short but stout spine, outer lobe with a small and a large spine. Distal segment of maxilla with a short stout spine, apically lobed long spine and a few denticles, unguis with strongly dentate borders. Distal segment of maxilliped with strongly curved unguis.

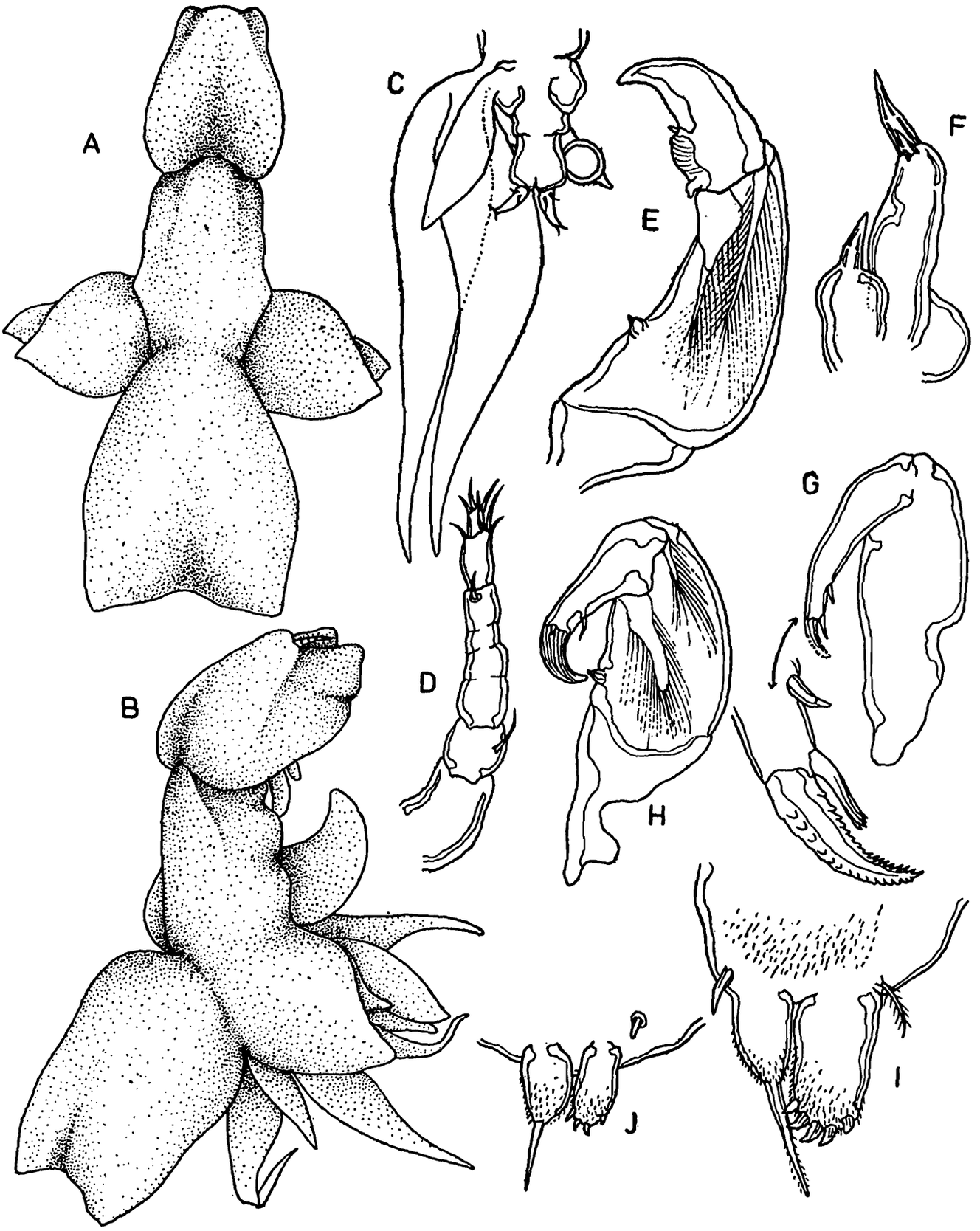


Fig. 201. *Lernanthropus robustus* Pillai : A, female, dorsal view ; B, same, lateral view ; C, posterior part of trunk ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H, maxilliped ; I-J, legs 1-2.

Exopod of first leg rectangular, with five strong teeth, endopod much smaller, with long apical spine, inner spine on basipod stout, outer setiform. Second leg with comparatively small rami, teeth on exopod small, spine on endopod long. Third legs pyriform, distally bilobed, indicating the biramous condition. Fourth leg with long subsimilar rami, proximally very broad and steadily narrowing towards the tip, reaching far beyond the dorsal plate. Fifth leg foliaceous, well developed, reaching beyond the tip of the caudal rami.

*Length.*—8.7 mm.

*Host.*—*Caranx* sp.

*Distribution.*—India (Kerala).

*Holotype and Allotype* in the National Zoological Collection at the Zoological Survey of India, Calcutta. Reg. No. C 4442/1 and C 4443/1.

### **Lernanthropus rubiginosus** Redkar, Rangnekar and Murti

*Lernanthropus rubiginosus* Redkar et al, 1949, p. 46, figs. 36-44 ; Tripathi, 1962a, p. 207, 215 ; Yamaguti, 1963, p. 151, pl. 164, fig. 3.

*Host.*—*Chatoessus nasus* (*Nematalosa nasus*).

*Distribution.*—India (Bombay).

*Remarks.*—This species as already indicated remotely resembles *L. oblongus* Pillai and the two may be synonymous. As I could not study specimens I am giving below the salient characters based on the original description which is the only one so far available.

Cephalothorax hexagonal. Trunk much broader than cephalothrox and nearly twice as long as the latter, antero-laterally produced forwards into triangular lobes. Dorsal plate formed in continuation of the anterior division of trunk. Andomen and caudal rami exposed. Antennule indistinctly five-jointed. Basal segment of antenna rather broad, distal long and slender. Inner lobe of

maxillule with one and outer with two spines. Distal joint of maxilla shorter than basal, with one distal spine. Basal segment of maxilliped rather swollen, distal long and curved. Exopod of first leg with five subsimilar teeth, that of second with four dissimilar teeth, endopod of second much longer than that of first. Structure of third leg not evident from the description. Fourth leg biramous, endopod very short, just overreaching dorsal plate, exopod very long, about twice as long as body, slightly narrowing backwards.

Cephalothorax of male elliptic, antennular lobe large, trunk shorter and narrower than cephalothorax, demarcated into three segments. All the appendages partially visible in dorsal view.

## **Lernanthropus sciaeni** Gnanamuthu
(Fig. 202)

*Lernanthropus sciaeni* Gnanamuthu, 1947b, p. 291, figs. 1-3 ; Yamaguti, 1963, p. 151 ; Pillai, 1967d, p. 1627, fig. 150.

*Female*.—Cephalothorax slightly longer than broad, gradually widening backwards, lateral lobes small, not projecting in front. Antennular lobe large and projecting. Anterior division of trunk broader than cephalothorax, gradually widening backwards and postero-laterally fusing with the third legs. Dorsal plate partially demarcated from trunk, basally narrow and steadily widening backwards, hind border irregularly rounded, antero-lateral parts folded downwards. Fourth and fifth segments indistinct but visible. Genital segment broader than long. Abdomen short, narrowing distalwards. Caudal rami about three times as long as abdomen.

Antennule eight-jointed, basal segment stout. Basal segment of antenna broad, distal rather short, proximally broad. Inner lobe of maxillule small, with one small spine, outer long, with one stout and two slender spines. Distal segment of maxilla as long as basal, equally broad throughout, with a curved distal inner process, unguis with sharp spines. Basal segment of maxilliped moderately stout, basal part of distal segment swollen, distal part narrow.

Basipod of first leg externally with stiff hairs, exopod stout, with five strong teeth, endopod small, with apical spine, inner spine on

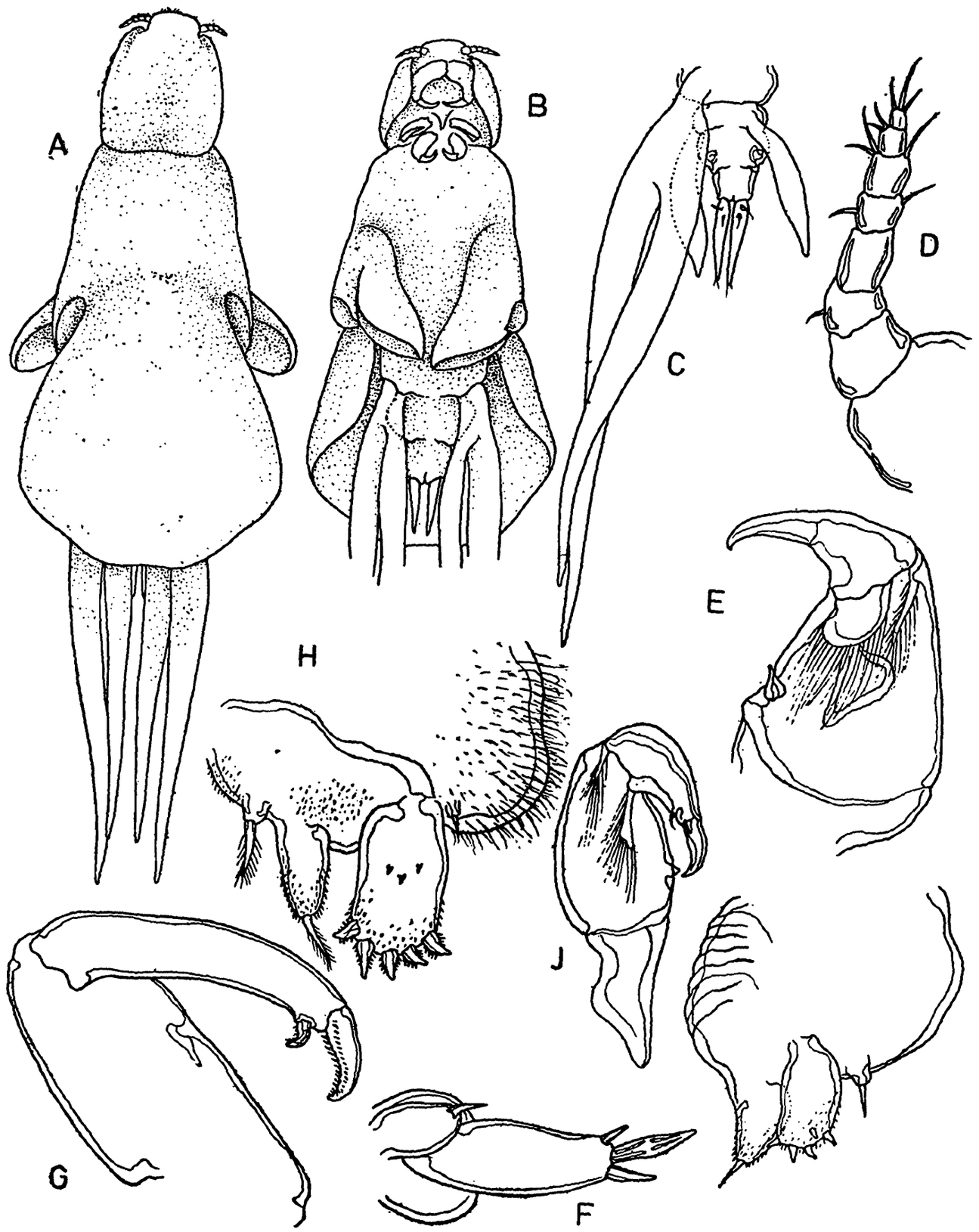


Fig. 202. *Lernanthropus sciaeni* Gnanamuthu : A, female, dorsal view ; B,same, ventral view; C, posterior part of trunk; D, antennule; E, antenna; F, maxillule ; G, maxilla ; H-I, legs 1-2 ; J, maxilliped.

basipod stout and pectinate. Outer seta on basipod of second leg mounted on a stout base, rami small, teeth and spine very small. Fourth leg with long slender subequal rami extending far beyond the dorsal plate. Fifth leg uniramous, reaching the tip of the caudal rami.

*Length.*—2.2 mm.

*Host.—Sciaena glaucus.*

*Distribution.*—India (Madras, Kerala).

*Holotype.*—Female in the National Zoological Collection at the Zoological Survey of India, Calcutta. Reg. No. C 2551/1.

*Remarks.*—I have compared my specimens with the holotype in the Indian Museum. Gnanamuthu's description of this species is rather inaccurate. His description of the fourth leg as triramous is wrong as he has taken the fifth leg as the third ramus of the fourth leg.

### **Lernanthropus secutoris** Pillai
(Fig. 203)

*Lernanthropus secutoris* Pillai, 1963c, p. 662, fig. 4 ; 1967d, p. 1631, fig. 162.

*Female.*—Cephalothorax large, narrowing backwards and overlapping the trunk, anterior border prominently trilobed. Anterior division of trunk nearly squarish, demarcated from dorsal plate by shallow lateral constrictions. Dorsal plate nearly circular, slightly broader than trunk, leaving the tip of the abdomen and the caudal rami exposed. Fourth segment visible but partially fused with the complex formed by the complete fusion of the fifth and genital segments. Abdomen small, widening backwards. Caudal rami shorter than abdomen, with two small setae and two spinules.

Antennule seven to eight-jointed and moderately well setose, associated with a curved stylet arising slightly behind its base, surface of cephalothorax near the antennular base spiny. Basal segment of antenna stout, sharply narrowing distalwards, internally covered with tubercles, distal segment slender and curved,

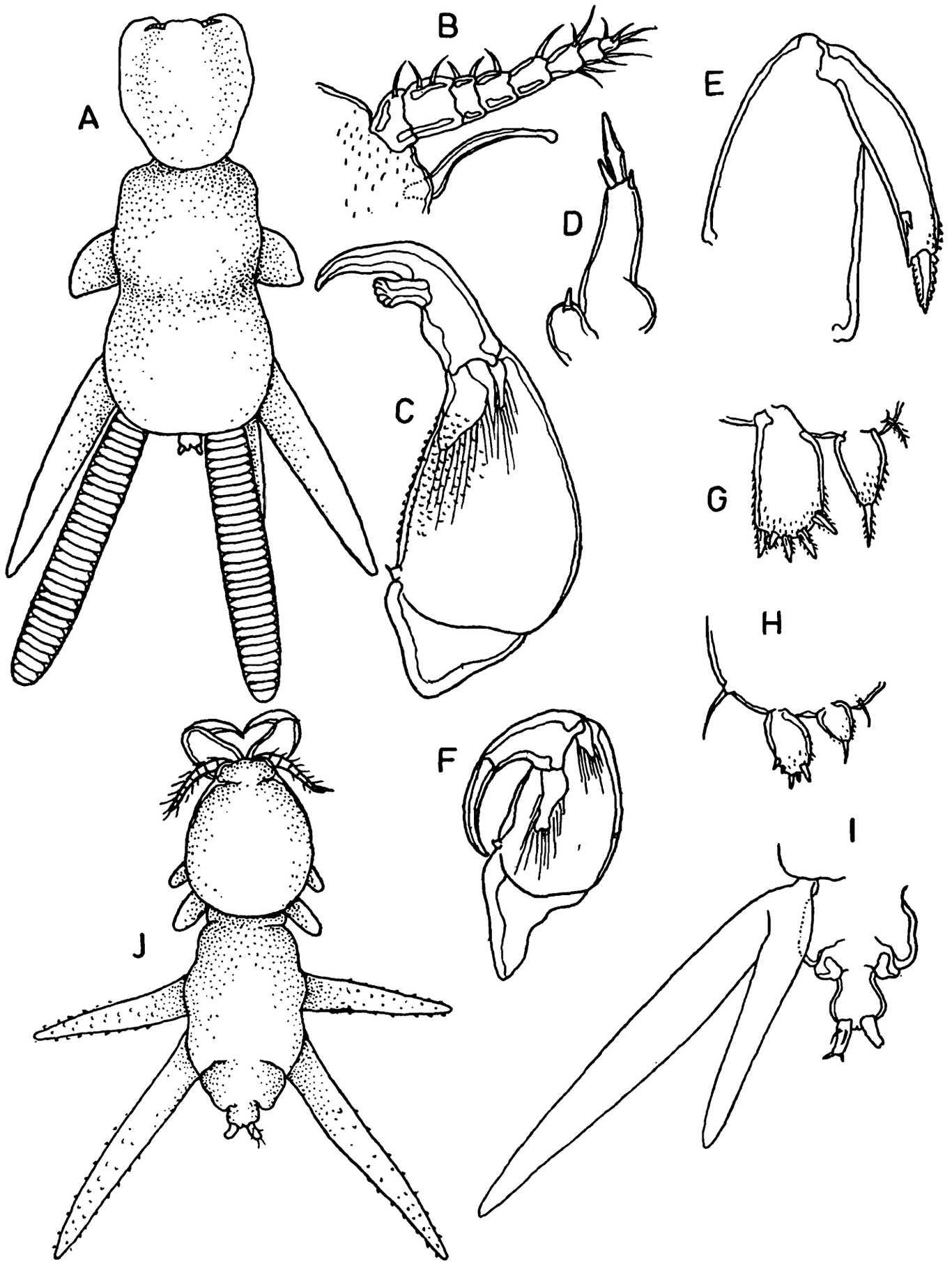


Fig. 203. *Lernanthropus secutoris* Pillai : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxillule ; E, maxilla ; F, maxilliped ; G-H, legs 1-2 ; I, posterior part of body ; J, male, dorsal view.

with an inner median stout process with grooved and expanded tip. Inner lobe of maxillule small, with one spine, outer with one large and two small spines. Distal segment of maxilla with a small patch of teeth and a forked spine, unguis small and bilaterally dentate. Basal segment of maxilliped moderately stout, distal segment long, slender and strongly curved, unguis as long as basal part.

Basipod of first leg with inner and outer setae, exopod much longer than endopod, with five comparatively large teeth, endopod with apical spine. Basipod of second leg with outer and inner setae, former long, exopod with five small spines, endopod with a short spine. Third legs biramous, exopods longer and cup-like, endopods fused into a tongue-like lobe. Fourth legs biramous, endopod much shorter than exopod. Fifth leg absent.

*Length.*—1.3 mm.

*Male.*—Cephalothorax large, ovate, an antennular lobe faintly marked. Thoracic segments completely fused, the composite segment formed by the fifth and genital segments partially distinct. Abdomen small. Legs three and four uniramous and tubercular. Fifth leg setiform.

*Length.*—1.0 mm.

*Host.*—*Secutor insidiator.*

*Distribution.*—India (Kerala).

*Type* in the National Zoological Collection at the Zoological Survey of India, Calcutta. Reg. No. C 4343/1

*Remarks.*—The armature of the antenna easily distinguishes this species. *L. corniger* Yamaguti has antenna with accessory process on distal segment but in all other features it is different from *L. secutoris.*

## **Lernanthropus sillaginis** Pillai
(Fig. 204)

*Lernanthropus sillaginis* Pillai, 1963c, p. 666, fig. 6 ; 1967d, p. 1627, fig. 151.

*Female.*—Cephalothorax roughly circular in outline, laterally produced into moderately large lobes projecting antero-laterally as small lobes. Antennular lobe fairly broad. Anterior division of trunk large, steadily widening backwards and enlarging into a broad dorsal plate with even or slightly irregular hind border. Fourth, fifth and genital segments fused. Abdomen sharply broadening backwards. Caudal rami large, longer than abdomen.

Antennule eight-jointed. Antenna slender, distal segment comparatively stout and well curved, base swollen, carrying a blunt spine. Inner lobe of maxillule with two and outer with three spines, median spine large. Distal segment of maxilla longer than basal, its distal part with two small spines and a few spinules, unguis with spiny borders. Maxilliped slender, distal segment rather long and apically well curved.

Exopod of first leg with the teeth steadily increasing in length inwards, endopod with a long pectinate spine. Rami of second leg comparatively larger, spines on exopod smaller than those on first leg. Third legs fused together, biramous, exopods longitudinally folded, forming some sort of a bell, endopods partially fused and projecting like the tongue of the bell. Fourth leg biramous, endopod shorter but broader than exopod, both clearly projecting beyond the dorsal lobe. Fifth leg absent.

*Length.*—2.5 mm.

*Host.*—*Sillago sihama.*

*Distribution.*—India (Kerala).

*Holotype* in the National Zoological Collection at the Zoological Survey of India, Calcutta. Reg. No. C 4345/1.

*Remarks.*—Kirtisinghe (1964) referred specimens collected from *Sillago sihama* at Ceylon to *L. villiersi* Delamare-Deboutteville

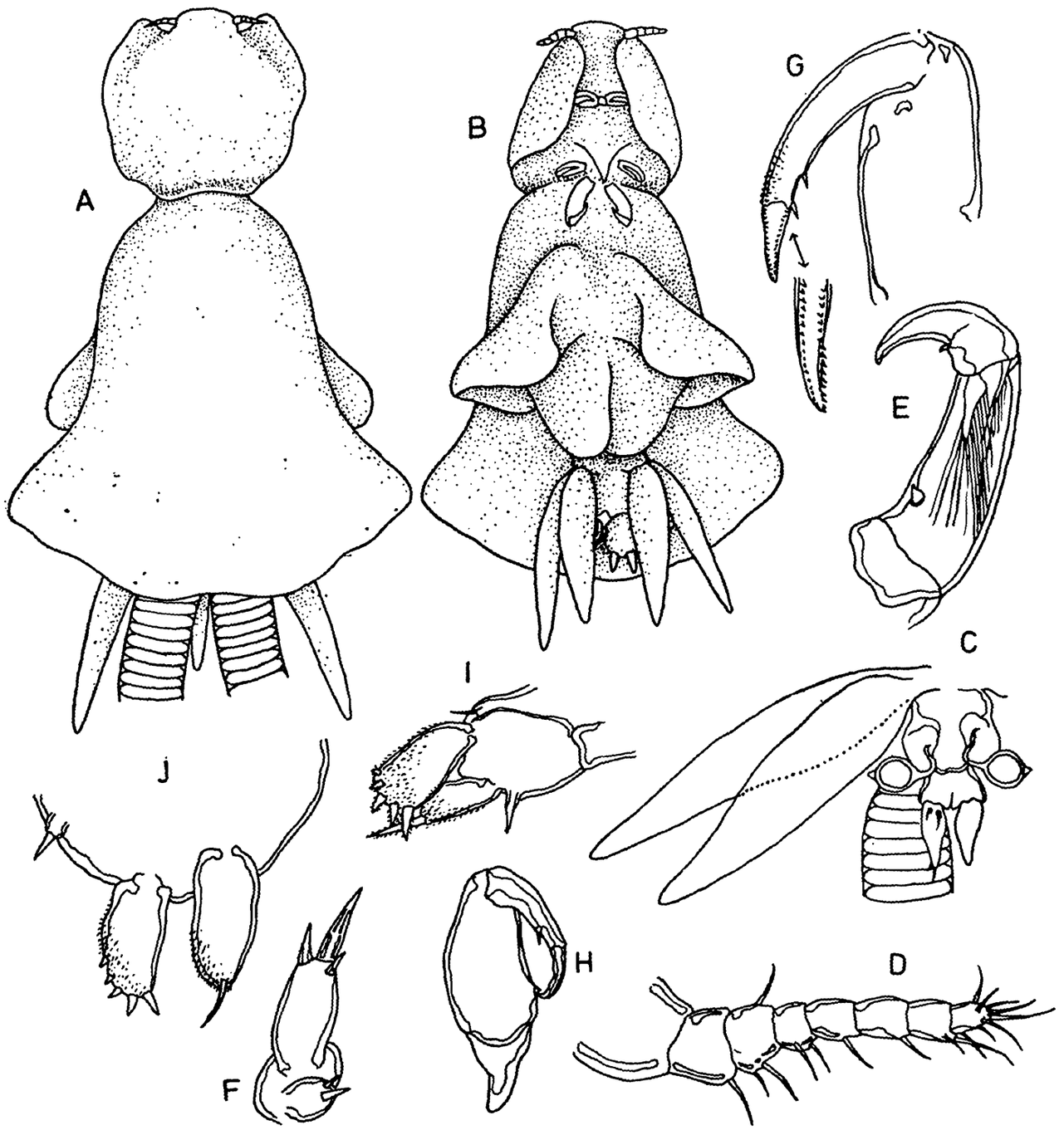


Fig. 204. *Lernanthropus sillaginis* Pillai : A, female, dorsal view ; B, same, ventral view ; C, posterior part of body ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H, maxilliped ; I-J, legs 1-2.

and Nunes-Ruivo. *L. villiersi* certainly shows close resemblance to *L. sillaginis* but in the former the dorsal plate is appreciably narrower and of a totally different shape. More over it has its

hind border clearly bilobed while in *L. sillaginis* it is entire. A final decision should await a direct comparision of the material.

## **Lernanthropus shishidoi** Shiino
(Fig. 205)

*Lernanthropus shishidoi* Shiino, 1955a, p. 64, figs. 6-7 ; Yamaguti, 1963, p. 151, pl. 162, fig. 1 ; Kirtisinghe, 1964, p. 93, fig. 124 ; Pillai 1964b, p. 69, figs. 60-62 ; 1967d, p. 1628, fig. 152.

*Female.*—Cephalothorax, anterior division of trunk and the dorsal plate nearly circular and subequal in size. Cephalothorax with antero-lateral and postero-lateral parts somewhat angular. Antennular lobe large and well defined. Anterior division of trunk longer than cephalothorax and connected to the latter by a short neck. Dorsal plate postero-laterally produced into large rectangular lobes with rounded tips. Fifth and genital segments fused. Abdomen long, basally swollen. Caudal rami oblong, with five setae.

Antennule six-jointed, basal segment very large. Antenna strong, basal segment swollen, with proximal inner spine, distal segment a short, stout, very slightly curved claw with a proximal spine. Each lobe of the maxillule with two spines. Basal segment of maxilla stout, distal half of inner border of distal segment serrate, unguis short and stout, with two rows of teeth. Maxilliped with well curved stout distal segment carrying a median inner spine, proximal part of basal segment with two prominent swellings carrying strong spines, with another spine between them.

Basipod of first leg with rows of sharp denticles and inner stout spine and outer slender seta. Exopod comparatively very broad, with five short but stout irregularly barbed teeth, endopod small, without armature. Second leg similar to first but much smaller, inner seta on basipod absent, exopod with one of the five teeth small, endopod longer than that of first. Third leg small, uniramous and longitudinally folded. Fourth leg biramous, exopod longer than endopod, as long as the body. Fifth leg absent.

*Length.*—4.1 mm.

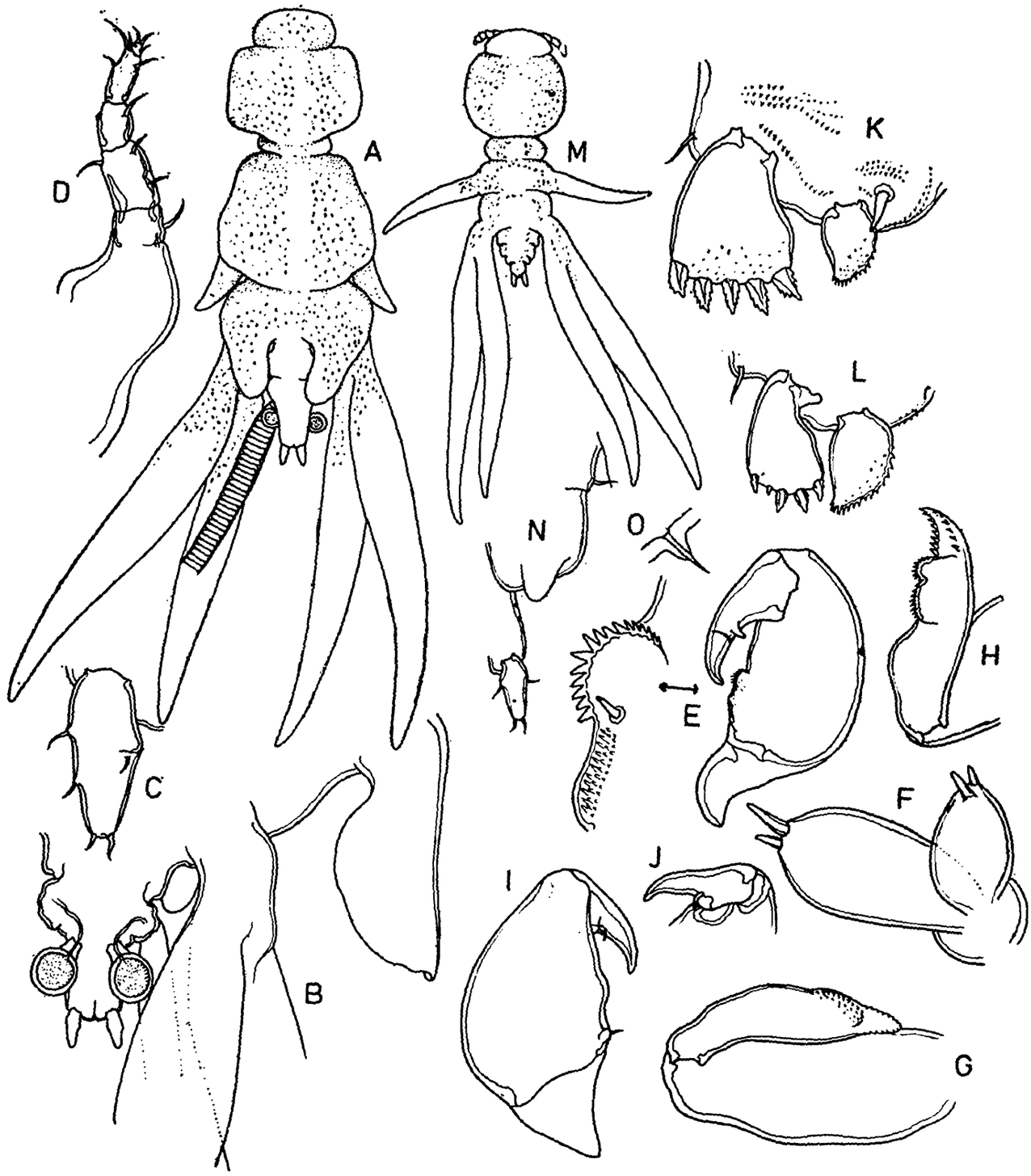


Fig. 205. *Lernanthropus shishidoi* Shiino : A-L, Female. A, female, dorsal view ; B, posterior part of body ; C, caudal ramus ; D, antennule ; E, maxilliped ; F, maxillule ; G, maxilla ; H, same, tip, lateral view ; antenna ; J, same, tip, inner view ; K-L, legs 1-2. M-O, Male. M, male, I, dorsal view ; N, hind part of body ; O, leg 5.

*Male.*—Segmentation of body fairly distinct. Cephalothorax large and circular. Antennular lobe distinct but less projecting than in female. Second, third, fourth and fifth trunk segments and genital segment free. Abdomen nearly as long as broad. Caudal rami oblong, with two proximal and two distal setae. Genital segment postero-laterally produced on either side of the abdomen. Third leg uniramous, narrowing and directed outwards. Fourth leg long and biramous, similar to that of female. Fifth leg setiform.

*Length.*—2.5 mm.

*Host.—Pagrosomus unicolor, P. major, Sparus macrocephalus, Mugil cephalus.*

*Distribution.*—Japan, India (Kerala), Sri Lanka.

*Remarks.*—The present specimens have the divisions of the body more clearly marked than shown by Shiino. The claws on the exopod of legs one and two are dentate. This species has several unique characters making its recognition easy.

### **Lernanthropus sphyraenae** Yamaguti and Yamasu

*Lernanthropus sphyraenae* Yamaguti and Yamasu, 1959, p. 126, pl. 11, figs. 221-230 ; Kirtisinghe, 1964, p. 95, fig. 125 ; Yamaguti, 1963, p. 151, pl. 166, fig. 1.

*Host.—Sphyraena pinguis, S. obtusata.*

*Distribution.*—Japan, Sri Lanka

*Remarks.*—This species is included in the present report on the strength of Kirtisinghe's record from Sri Lanka.

Cephalothorax slightly broadening backwards, antero-laterally forming moderately large lobes folded downwards and produced forwards as prominent rounded lobes, border between the lobes nearly transverse. Anterior division of trunk widening backwards and prolonged as the dorsal plate, latter with prominent posterior

incision making it bilobed. Abdomen visible in dorsal view. Antennule seven-jointed, associated with a chitinous process. Antenna with a simple stout claw. Inner lobe of maxillule with two and outer with three spines. Terminal segment of maxilla with a spine, unguis sparsely dentate. Claw of maxilliped simple. Exopod of first leg with five stout teeth, endopod with a spine. Basipod of second leg conically produced on the outer side, exopod small, with five small teeth, endopod elongate conical. Third legs biramous, exopods fused with the anterior division of trunk, endopods fused into a linguiform lobe, distally bilobed. Fourth legs short, moderately overreaching the dorsal plate, rami subequal in length.

Yamaguti and Yamasu stated that this species is unique "in the trunk possessing a pair of large dorso-lateral lobes, a pair of ventro-lateral lobes and a fluted ventro-median lobe" This description is somewhat misleading. At any rate a similar condition is evident in *L. decapteri* Pillai and *L. forficatus* Redkar et al.

### **Lernanthropus triangularis** Pillai
(Fig. 206)

*Lernanthropus triangularis* Pillai 1963c, p. 668, fig. 7.

*Female.*—Cephalothorax longer than broad, antennular lobe twice as broad as antero-lateral lobes. Anterior division of trunk as long as cephalothorax, widening backwards. Dorsal plate broader than anterior division of trunk, roughly squarish and broader behind. Fourth segment not distinct. Fifth segment fused with genital segment. Abdomen small, as long as broad. Caudal rami longer than abdomen, with two proximal setae and two distal spines.

Antennule associated with a curved process, eight-jointed and moderately setose. Antenna comparatively slender, basal segment with prominent process carrying a spine, distal segment comparatively stout. Both lobes of maxillule ovate, inner with one and outer with three spines. Distal segment of maxilla nearly as long as basal, with two spines, unguis moderately long. Distal segment of maxilliped slender, with two sharp spines.

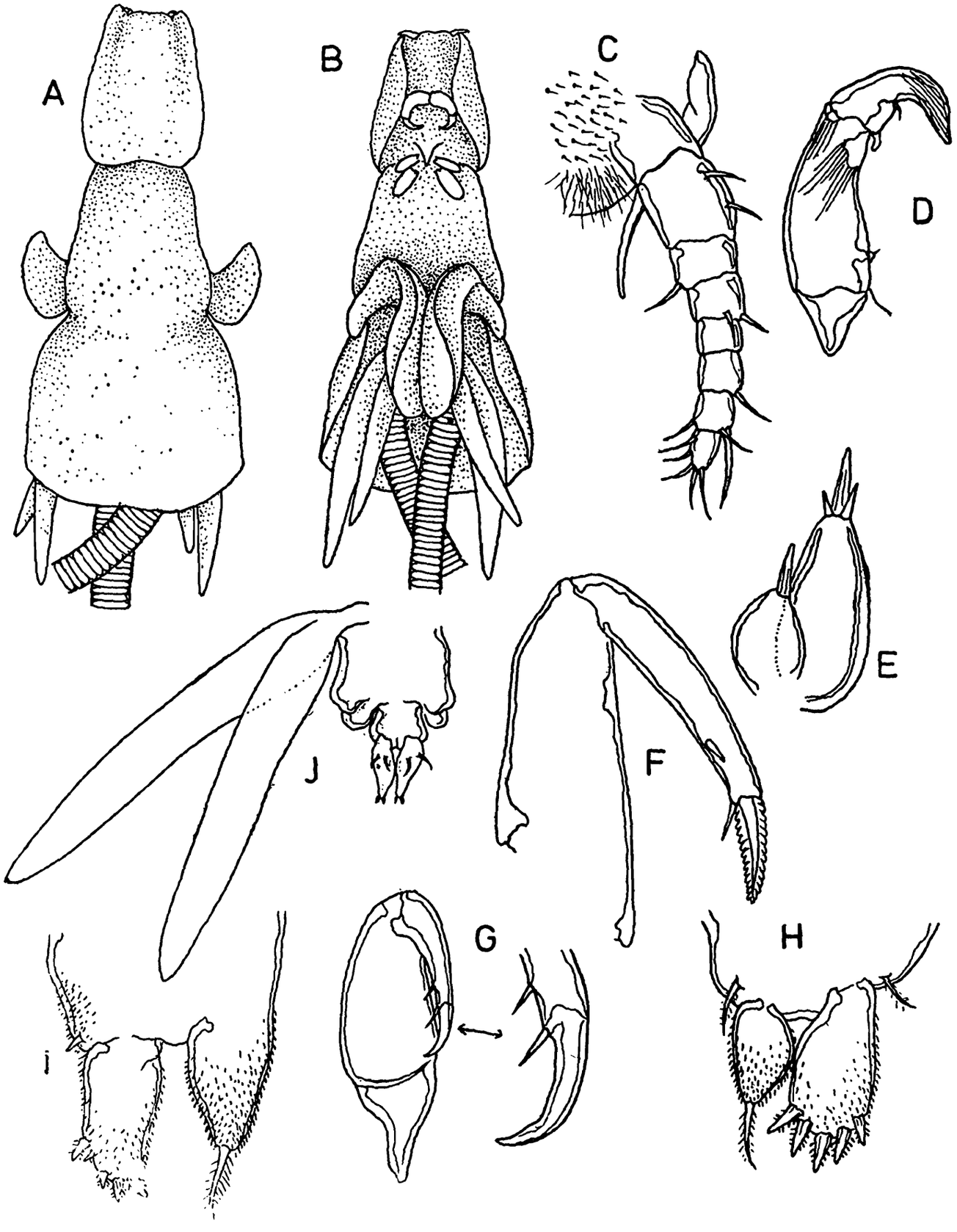


Fig. 206. *Lernanthropus triangularis* Pillai : A, female, dorsal view ; B, same, ventral view ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H,-I, legs 1-2 ; J, posterior part of body.

Basipod of first leg with inner and outer setae, exopod with five fairly stout teeth, endopod smaller than exopod, with long pectinate apical spine. Basipod of second leg with outer spine, rami subequal in size, exopod with two of the teeth small. Third legs biramous, exopods longitudinally folded, endopods partially fused, with curled edges. Fourth leg with subsimilar rami. Fifth leg absent.

*Length.*—2.4 mm.

*Male.*—Body demarcated into cephalothorax and trunk, latter only slightly longer than cephalothorax. Trunk segments fused. Abdomen projecting. Third leg uniramous, endopod represented by a lobe. Fourth leg biramous, endopod much smaller than exopod.

*Length.*—0.9 mm.

*Host.*—*Gerres filamentosus.*

*Distribution.*—India (Kerala).

*Types* in the National Zoological Collection at the Zoological Survey of India, Calcutta. Reg. No. C 4346/1 & C 4347/1.

## **Lernanthropus trifoliatus** Bassett-Smith
(Fig. 207)

*Lernanthropus trifoliatus* Bassett-Smith, 1898a, p. 11, pl. 7, fig. 3 ; Tripathi, 1962a, p. 204, figs. 28-29 ; Pillai, 1963c, p. 655, fig. 1 ; (nec Kirtisinghe, 1956, p. 18, fig. 11 ; Yamaguti, 1963, p. 152, pl. 165, fig. 5.).

*Female.*—Cephalothorax broadest in the middle, posteriorly convex and overlapping trunk. Antennular lobe low, antero-lateral parts rounded and slightly projecting. Anterior division of trunk widening backwards, slightly longer than broad, demarcated from the dorsal plate by a constriction. Dorsal plate slightly longer than broad, distally rounded. Fourth segment fairly distinct. Fifth segment fused with genital segment. Abdomen fairly large. Caudal rami large, spinulose, partially fused with abdomen.

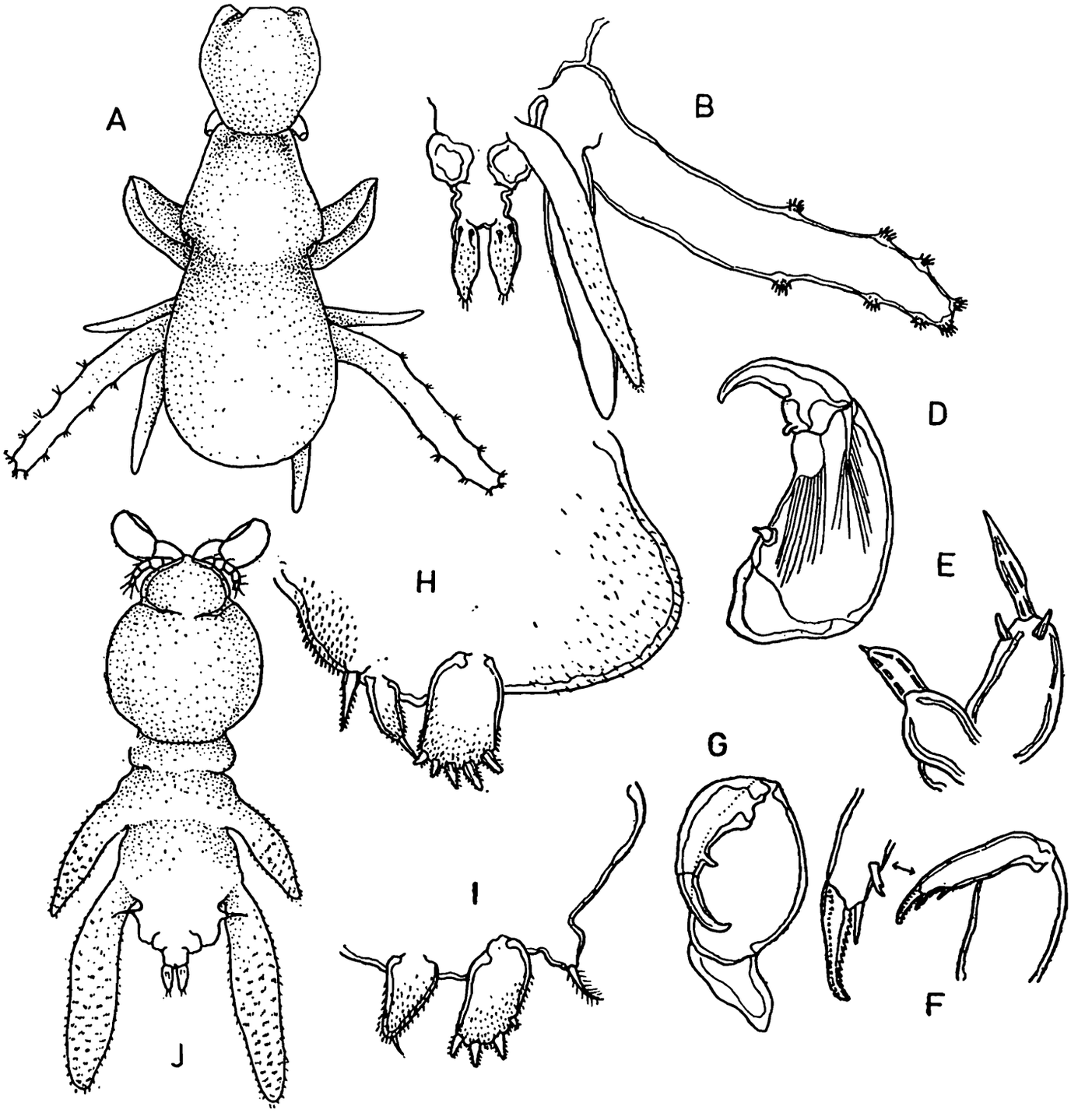


Fig. 207. *Lernanthropus trifoliatus* Bassett-Smith : A-I, Female. A, female, dorsal view ; B, posterior part of body ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2. J, Male, dorsal view.

Antennule fairly stout, seven-segmented, with the normal compliment of setae. Basal segment of antenna stout, with a proximal inner spine, basal part of distal segment swollen, distal short and slightly curved. Inner lobe of maxillule with one stout process, outer lobe comparatively short, with one stout and two small

spines. Distal segment of maxillule with two spines, unguis bilaterally dentate, long and slender. Basal segment of maxilliped rather swollen, distal segment long and strongly curved, with an inner accessory process.

Basipod of first leg expanded into a large spinulose pad, exopod comparatively stout, endopod small, with a short apical setule. Exopod of second leg only moderately larger than endopod, latter with a small spinule, outer seta on basipod mounted on a swollen base. Third leg small, uniramous and longitudinally folded. Fourth leg biramous, outer ramus much longer and stouter than inner, distally with projecting marginal bunches of spines, border between the bunches concave, giving the ramus a characteristic appearance. Fifth leg nearly as long as the inner ramus of fourth leg, distal part with microscopic spinules.

*Length.*—2.3 mm.

*Male.*—Cephalothorax large. Antennular lobe large, clearly demarcated by lateral grooves. Trunk narrower than cephalothorax, segments faintly demarcated. Genital segment broad. Abdomen small. Caudal rami as long as abdomen. Third and fourth legs uniramous, endopod represented by a small lobe, fourth leg much longer than third, both with spiny surface. Fifth leg setiform.

*Length.*—1.1 mm.

*Host.—Polynemus sextarius, P. heptadactylus, p. tetradactylum.*

*Distribution.*—India (Bombay, Kerala, Orissa).

*Remarks.*—The only important difference between *L. trifoliatus* and *L. lappaceus* is the shape of the fourth leg in both sexes and in the size of the body. But *L. trifoliatus* varies in size and in the shape of the fourth legs depending on the size of the host. It is rather difficult to assign some collections to either species.

While describing *L. microlamini* Hewitt observed that it resembles *L. trifoliatus* and a group of species resembling *L. giganteus*, parasitic on carangids. This is rather surprising since the fourth

legs readily distinguish *L. trifoliatus* from all the other species except perhaps *L. lappaceus*. This confusion seems to have arisen from Kirtisinghe describing specimens of *L. giganteus* as *L. trifoliatus*.

## **Lernanthropus tylosuri** Richiardi
(Fig. 208)

*Lernanthropus tylosuri*; Cressey and Collette, 1970, p. 387, figs. 157-162, pls. 3-4.

*Lernanthropus cornutus* Kirtisinghe, 1937a, p. 448, figs. 88-98 ; Capart, 1953, p. 649 ; Delamare-Deboutteville and Nunes Ruivo, 1954b, p. 141, fig. 2 ; Yamaguti, 1963, p. 148 ; Pillai, 1963c, p. 658, fig. 2.

*Female.*—Cephalothorax longer than broad, laterally produced into large flaps folding downwards and projecting forwards as two blunt low processes. Postero-lateral parts produced into a pair of digitiform horns directed outwards and backwards. Antennular lobe very low. Anterior division of trunk gradually broadening backwards, antero-medially produced into a low boss overlapping cephalothorax. Trunk imperceptibly continued as the dorsal plate which progressively widens and at the distal third narrows ending in an angular tip. Dorsal plate with a dorso-median carina progressively narrowing backwards. Fourth segment large, indistinctly demarcated. Fifth segment fully fused with genital segment. Postero-median part of abdomen projecting. Caudal rami fully fused with abdomen, diverging and with five distal setae.

Antennule eight-jointed, first segment enlarged, last very small. Antenna stout, basal segment with inner spine, distal segment robust, with two basal spines. Inner lobe of maxillule comparatively large, with a stout spine, outer lobe with three spines, one of them small. Distal segment of maxilla short, with a few large teeth, unguis with several rows of teeth. Maxilliped as stout as antenna, inner part of basal segment with two patches of spinules, apical part of distal segment curved and grooved.

Exopod of first leg stout, with short blunt teeth, endopod with a long pectinate apical spine, outer seta slender, inner stout, inner part of basipod with a patch of spinules. Second leg much smaller than first, one of the spines on exopod large, one very small, outer seta long and placed on a dumb-bell-shaped stout base. Third

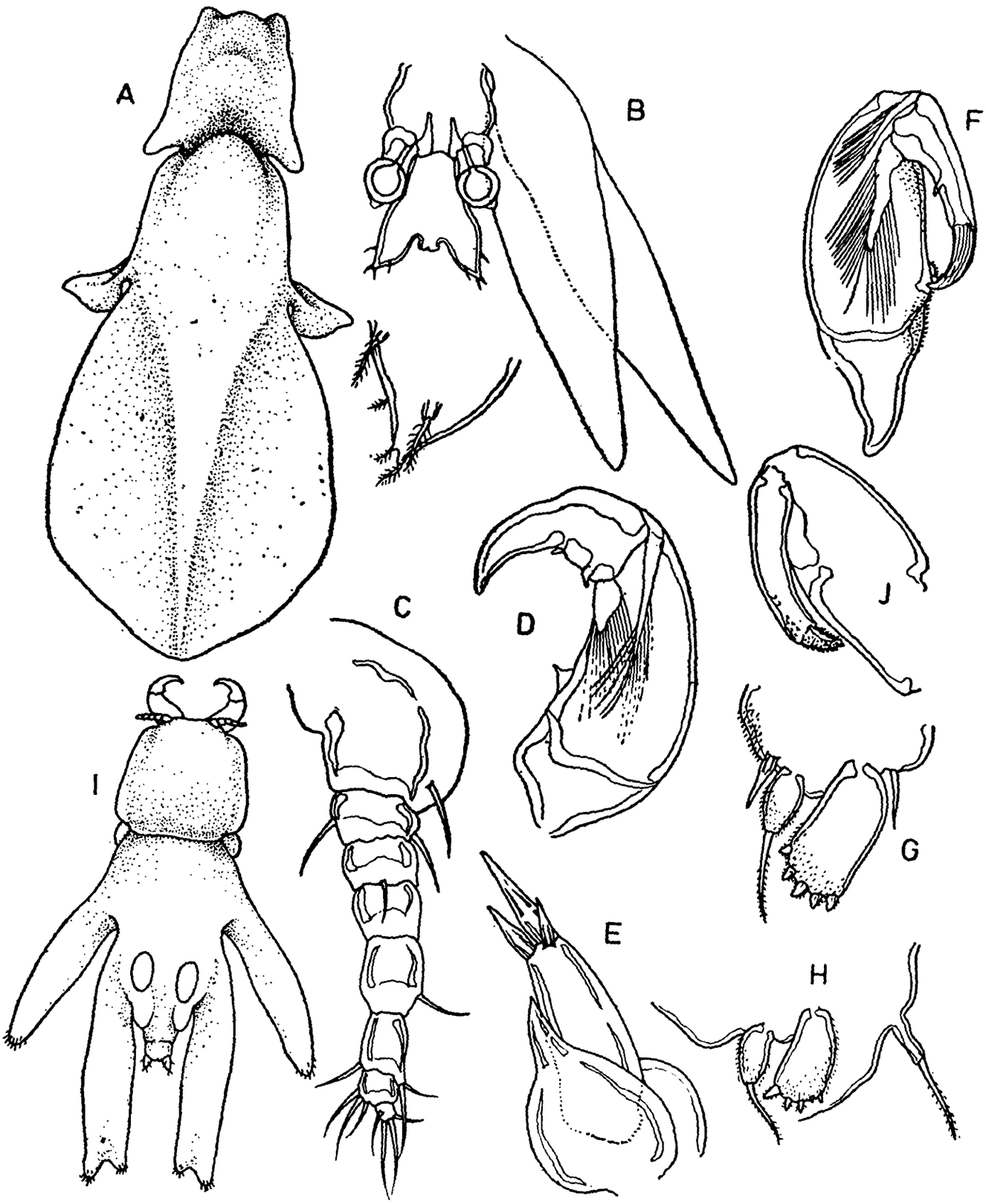


Fig. 208. *Lernanthropus tylosuri* Richiardi ; A-H, J, Female. A, female, dorsal view ; B, posterior part of trunk ; C, antennule ; D, antenna ; E, maxillule ; F, maxilliped ; G-H, legs 1-2. I, Male, dorsal view. J, maxilla, female.

legs small, uniramous and longitudinally folded. Fourth leg stopping far short of the tip of the dorsal lobe, rami rather broad, exopod slightly longer. Fifth leg absent.

*Length.*—7.8 mm.

*Male.*—Cephalothorax roughly squarish, broader behind, antennular lobe not clearly demarcated. Trunk segments, unlike as in other species, fully fused. Fifth and genital segments fused. Abdomen short but distinct. Caudal rami as long as abdomen, with five setae. Third leg a flattened apically rounded and spiny lamina, no trace of the endopod as in other species. Fourth leg longer than third, apically forked, limbs of the fork with apical bunch of spines. Fifth leg not observed.

*Length.*—1.7 mm.

*Host.—Ablennes hians, Platybelone argalus, Strongylura leiura, S. exilis, S. incisa, S. marina, S. strongylura, S. timuca, S. urvillii, S. anastomella, Tylosurus acus, T choram, T crocodilus, T punctulatus.*

*Distribution.*—Sri Lanka, India (Kerala), Red Sea, Kenya, Madagascar, Mauritius, Persian Gulf, Gulf of Thailand, Java, Singapore, Borneo, Japan, Marshall islands, Hawaii, Mexico, Panama, Philippines, Venezuela, Woods Hole, Brazil, Peru, California, Mediterranean.

*Remarks.*—Two species, *L. belones* Kroyer and *L. tylosuri* Richiardi occur on needle fishes. They show close similarity but in *L. tylosuri* the cephalothorax is postero-laterally produced into digitiform processes and the dorsal plate narrows towards the tip which is angular. In *L. belones* the cephalic processes are absent and the dorsal plate is distally not narrowed. According to Cressey and Collette *L. tylosuri* is found on *Ablennes hians, Strongylura leiura, S. anastomella* and species of *Tylosurus. L. belones* is predominent on other species of *Strongylura.*

*L. cornutus* Kirtisinghe is undoubtedly a synonym of *L. tylosuri.*

## Genus **Lernanthropodes** Bere

*Lernanthropodes* Bere, 1936, p. 602 ; Pillai, 1962b, p. 614 ; Yamaguti, 1963, p. 145.

*Diagnosis.*—Cephalothorax as in *Lernanthropus*, lateral lobes comparatively larger. Anterior division of trunk long and cylindrical, without dorsal plate. Fourth, fifth and genital segments and abdomen exposed. Caudal rami slender and long. Egg tubes straight. Cephalic and thoracic appendages as in *Lernanthropus* but third legs fused into a dorso-medially open and laterally compressed tube enclosing the hind body and its appendages, its distal border entire or four lobed.

Male very much like that of *Lernanthropus.*

Type species.—*L. cuculus* Bere.

*Discussion.*—The conversion of the third pair of legs into a dorsally open tube covering and protecting the hind body and its appendages and the consequent disappearance of the dorsal plate distinguishes this genus. The four lobed distal border of the tube shows that it is formed by the fusion of a pair of biramous legs. Yamaguti has described this thus "exopod of third leg free, endopods fused along their inner margins" This is misleading. The absence of the dorsal plate consequent on the unusual development of the third legs seems to support my opinion that the dorsal plate of *Lernanthropus* is an extension of the third trunk segment.

### *Key to species of* **Lernanthropodes**

1. Hind border of the fused third legs entire . . *chorinemi* Pillai

— Hind border of the fused third legs four lobed . .2

2. Second segment of maxilla with two large distal spines *trachinoti* Pillai

— Second segment of maxilla without spines *cuculus* Bere

## **Lernanthropodes trachinoti** Pillai
(Fig. 209)

*Lernanthropodes trachinoti* Pillai, 1962b, p. 614, fig. 2 ; 1967d, p. 1635, fig. 172.

*Female.*—Cephalothorax triangular in dorsal view, broadening backwards, hind border deeply concave. Antennular lobe ill defined, lateral lobes large and folded vertically downwards. Anterior division of trunk stout and cylindrical, more than twice as long as broad. Fourth thoracic segment short but distinct. Fifth and genital segments fused. Abdomen large, as long as broad. Caudal rami longer than abdomen, with two basal and two apical setae.

Antennule fairly stout, seven-segmented, with fairly long setae. Antenna comparatively slender, basal segment with a spine mounted on a projection, distal segment heavily built, with two proximal processes, distal part strongly curved. Inner lobe of maxillule comparatively large, with one stout spine, outer lobe longer but narrower than inner, with two stout spines, one of them twice as long as the other. Basal segment of maxilla fairly large, distal segment distally spinulose and with two spines, one of them bifid, unguis with strongly serrate margins. Maxilliped much smaller than the antennae, distal segment stout and strongly curved.

Basipod of first leg spiny, with an outer seta and inner spine, exopod large, with five rather small teeth, endopod small, with a long stout spine. Basipod of second leg with the outer seta modified into a spine, exopod much smaller than that of first leg, two of the five teeth small, endopod subequal to exopod in size, spine shorter and more slender. Third legs fused into a dorsally open laterally compressed tube, its distal border four lobed, outer lobes smaller than inner. Fourth leg with short subsimilar rami, not overreaching the third legs.

*Length.*—4.5 mm.

*Host.—Trachynotus blochi.*

*Distribution.*—India (Kerala).

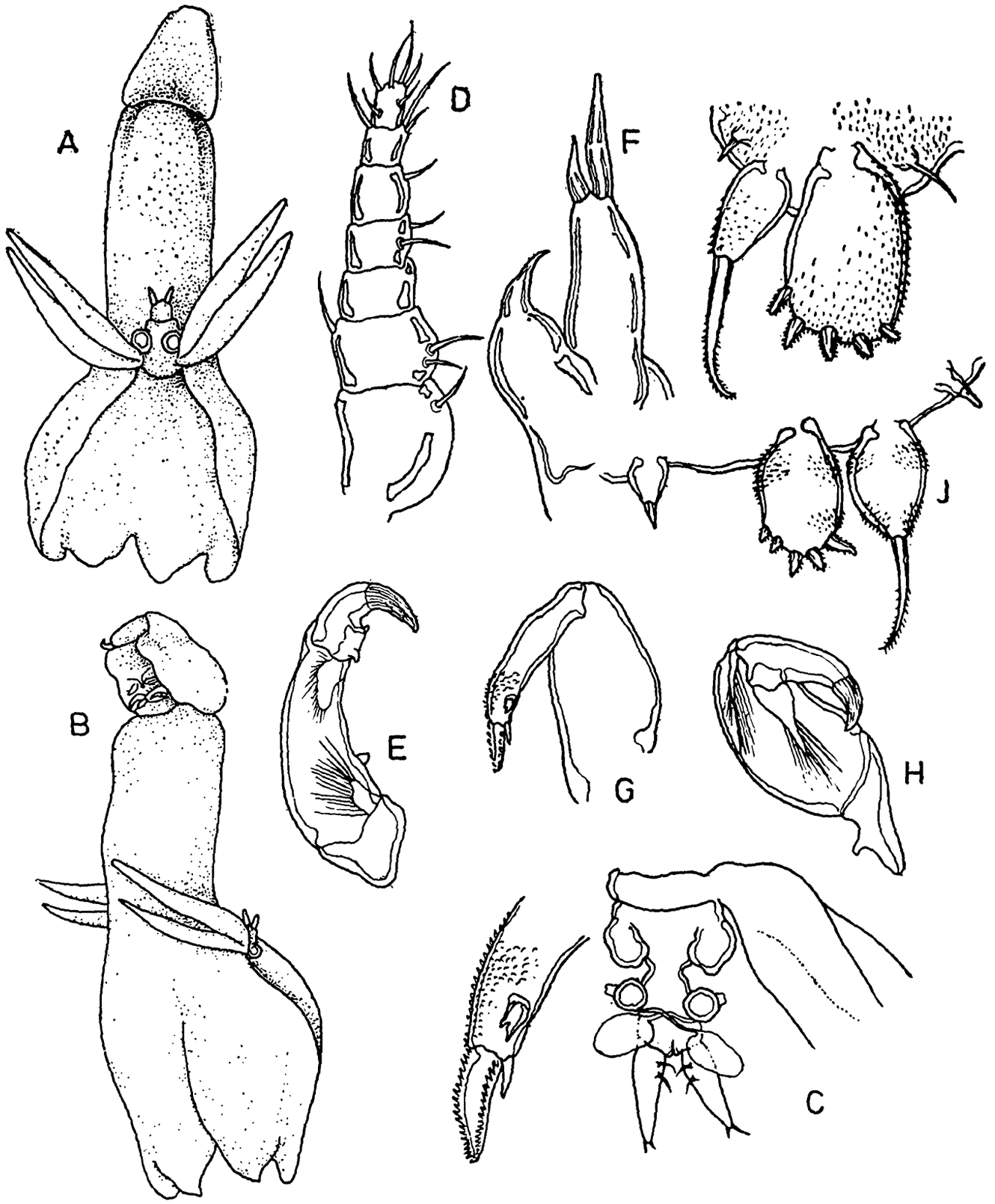


Fig. 209. *Lernanthropodes trachinoti* Pillai : A, female, dorsal view ; B, same, lateral view ; C, posterior part of trunk ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H, maxilliped ; I-J, legs 1-2.

*Holotype* female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2152/2.

*Remarks.*—This species closely resembles *L. cuculus* Bere and is distinguished by only minor differences. They may turn out to be the same.

**Lernanthropodes chorinemi** Pillai
(Fig. 210)

*Lernanthropodes chorinemi* Pillai, 1962b, p. 617, fig. 3 ; 1967d, p. 1635, fig. 173.

*Female.*—Body very much like that of *L. trachinoti.* Cephalothorax more prominently narrowing towards the front, antennular lobe very small. Anterior division of trunk slightly broadening backwards. Genital segment fused with fifth segment. Spermatophores with long apical process. Abdomen broader than long, as broad as genital segment. Caudal rami well developed, nearly twice as long as abdomen.

Antennule eight to nine-segmented, apical segment very small. Antenna stouter than in *L. trachinoti*, distal segment distally grooved, more slender and strongly curved. Inner lobe of maxillule with one and outer with three spines. Basal segment of maxilla stout, distal slender, as long as basal, distally pustulose and with three spines, unguis rather long, slender and bilaterally toothed. Maxilliped stout, basal segment with a single and a double boss, distal segment strongly curved.

Basipod of first leg sparsely pustulose, with inner and outer spine, exopod oblong, with five teeth successively increasing in size outwards, endopod internally spinulose, with long apical spine. Rami of second leg subequal in size, exopod with one small and four large teeth, basipod with a long outer spine. Distal border of third leg evenly convex. Fourth leg with subequal rami, overreaching the third legs. Fifth leg very small.

*Length.*—8.2 mm

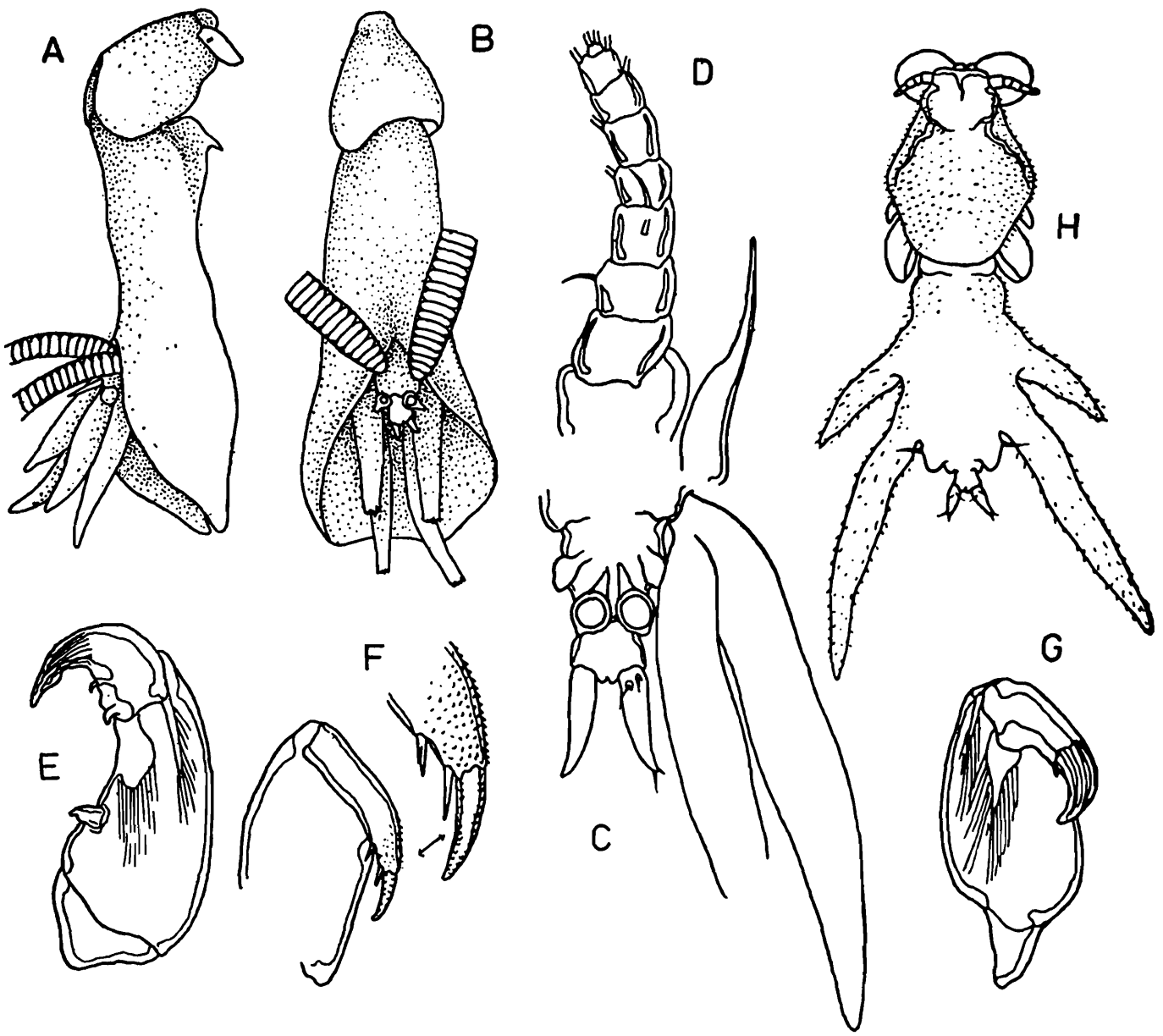


Fig. 210. *Lernanthropodes chorinemi* Pillai : A, female, lateral view ; B, same dorsal view ; C, posterior part of body ; D, antennule ; E, antenna ; F, maxilla ; G, maxilliped ; H, male, dorsal view.

*Male.*—Cephalothorax hexagonal, anterior and posterior parts truncated, median part produced and angular. Antennular lobe circular, delimited by chitinised ribs. Trunk nearly as long as cephalothorax, second segment faintly indicated, other segments fused. Genital segment transversely rectangular. Abdomen very small. Caudal rami longer than abdomen, surface spinulose. Dorsal side of body spinulose. Third leg comparatively short, fourth three times as long as third, both uniramous. Fifth leg setiform.

*Length.*—1.5 mm.

*Host.—Chorinemus sanctipetri, C. lysan.*

*Distribution.*—India (Kerala).

*Type.*—In the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2153/2.

*Remarks.*—This is the first record of the male of this genus. It has the antennular lobe clearly demarcated and the body spinulose. These two characters are clearly visible in several species of *Lernanthropus.*

## Genus **Aethon** Kroyer

*Aethon,* Hewitt, 1968b, p. 12.

*Diagnosis.*—Cephalon fused with first thoracic segment forming a cephalothorax with large lateral and antero-lateral lobes. Second and third thoracic segments dorsally indicated by transverse grooves or sutures. Dorsal plate large, separated off by more or less a distinct suture. Fourth and fifth segments indistinct. Genital segment large. Abdomen broader than long. Caudal rami large.

Cephalic appendages as in *Lernanthropus.* First and second legs as in *Lernanthropus.* Third legs biramous and very large, exopods larger, ventro-lateral, endopods ventral, protopods enlarged and produced forwards on either side of the anterior division of trunk as large lobes. Fourth leg biramous, basally flattened and distally suddenly narrowed. Egg tubes coiled.

Type species.—*A. quadratus* Kroyer.

*Discussion.*—Yamaguti (1963) treated *Aethon* as a synonym of *Lernanthropus* but Hewitt the only other person who seems to have dealt with this genus upheld its validity and described three species, two of them new. Hewitt is correct but one must admit that there is some justification for Yamaguti's action as a few species of *Lernanthropus* resemble *Aethon* in some fundamental characters.

The definition given by Hewitt needs some comment. He says that the second and third thoracic segments are fused but have separate dorsal plates and lateral expansions which do not fuse with the plate of the fourth segment. In the description of parasitic copepods there is indiscriminate mention of the presence of plates. The second and third trunk segments of *Aethon* are indicated by sutures but there are no dorsal plates. On either side of the anterior division of the trunk there is a large lobe which is actually an anterior extension of the enlarged protopod of the third legs. That this explanation is not a mere conjecture can be seen by the shape and structure of the third legs of *Lernanthropus lativentris* Heller. A comparative study of the third legs of *L. brevicephalus*, *L. nemipteri*, *L. priacanthi* and *L. lativentris* clearly shows the progressive growth of this leg. Hewitt has stated that the fourth legs are divided right down to their base. But the rami are suddenly narrowed distally though they cannot be described as whip-like as in *Sagum* and *Norion*.

*Aethon* resembles *Norion* to some extent. Thinking that *Aetho.* is not a valid genus I described a species collected from Kerala as *Norion globosus*. This action was prompted by the presence of antero-lateral lobes on the anterior division of the trunk as in *Nn expansus*. It is certain that *N. globosus* should be placed in *Aethon*.

It is true that *N. expansus* is different from all the other anthosomatids. In the light of the present study it would appear that the third legs of *Norion* lost the endopods and the exopods developed into large ventral plates. An identical condition exists in *L. brevicephalus*. The large lobes projecting on either side of the cephalothorax can only be the highly enlarged protopods of the third legs, an extreme development of what is indicated in *L. brevicephalus*.

I have expressed my opinion regarding the variations that have occurred in the various genera so that they may be scrutinised by future workers. Some of the species which can only be included in *Lernanthropus* show unmistakable affinity to *Sagum*, *Aethon* and *Norion*. The taxonomy of anthosomatids is somewhat confusing. This confusion is largely due to the inadequate description of many species described by early workers. The types of the various gerera if available should be redescribed.

*Key to species of* **Aethon**

1. Antero-lateral lobes of trunk and lobes of cephalothorax anteriorly angular — *globosus* (Pillai)
— Antero-lateral lobes of trunk and lobes of cephalothorax anteriorly rounded — *priacanthi* (Kirtisinghe)

## **Aethon globosus** (Pillai)
(Fig. 211)

*Norion globosus* Pillai, 1968a, p. 1, figs. 1-15.

*Female.*—Cephalothorax slightly longer than broad, antero-lateral parts expanded into large fleshy lobes bent downwards and also forwards as large wing-like lobes. Anterior division of trunk widening backwards, dorsally with two more or less distinct transverse grooves demarcating three segments. Dorsal plate pyriform, dome-shaped and posteriorly suddenly narrowed, posterior border very narrow, with slight median concavity. Fourth and fifth segments fused, genital segment large. Abdomen semicircular in outline, distal border transverse. Caudal rami basally bulged, with setae.

Antennule slender, seven-jointed. Antenna strong, basal segment proximally broad, distal segment stout, distally grooved. Inner lobe of maxillule nearly circular, with one long spine, outer ovate, with two spines. Basal segment of maxilla stout, distal slender, with a bifid process, inner distal part bulged and covered with small teeth, unguis not demarcated, covered with spinules. Maxilliped stout, distal part of distal segment grooved and highly chitinised.

Exopod of first leg large, roughly rectangular, with four teeth, endopod small, nearly rounded, basipod with stout inner spine. Second leg not observed, probably absent. Third leg biramous, endopod smaller than exopod, lamellar and ventral, exopod large, ventro-lateral and covered with spinules, protopod enlarged and produced forwards as two large wings on either side of the anterior division of trunk. Fourth leg biramous, exopod larger than endopod, both rami proximally broad and distally suddenly narrowed, exopod with outer basal seta. Fifth leg uniramous, oblong, with prominent seta.

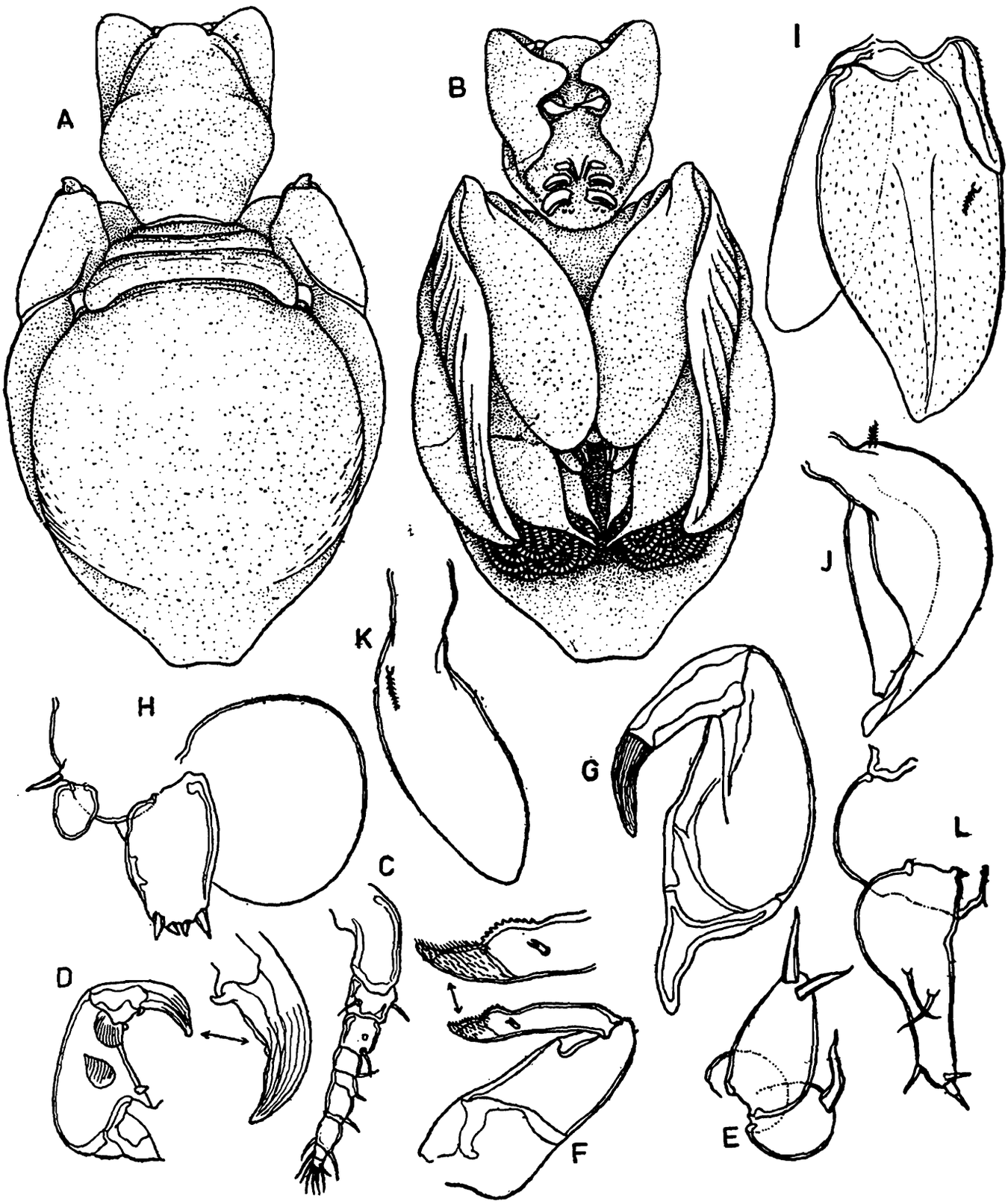


Fig. 211. *Aethon globosus* (Pillai) : A, female, dorsal view ; B, same, ventral view ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped; H, leg 1 ; I, leg 3 ; J, leg 4 ; K, leg 5 ; L, caudal ramus.

*Length.*—4.1 mm.

*Host.—Lutianus waigiensis.*

*Distribution.*—India (Kerala).

*Holotype.*—In the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2154/2.

*Remarks.*—As indicated in the discussion on the genus this species has distinctly biramous third legs and the exopod is not fused with the trunk. The trunk shows distinct segmentation. Hence it should be accommodated in *Aethon.*

**Aethon priacanthi** (Kirtisinghe)
(Fig. 212)

*Lernanthropus priacanthi* Kirtisinghe, 1956, p. 17, figs. 9-10 ; 1964, p. 95, figs, 126-127 ; Yamaguti, 1963, p. 151, pl. 165, fig. 2 ; Pillai, 1967d, p. 1629. fig. 156.

*Length.*—Female, 3.8 mm. and male, 1.8 mm.

*Host.—Priacanthus hamrur.*

*Distribution.*—Sri Lanka, India (Kerala).

*Remarks.*—This species was created by Kirtisinghe to describe specimens collected from *Priacanthus hamrur* at Ceylon. He gave a very short description of both sexes and also observed that it is very close to *L. larvatus* Heller. In his more recent work (Kirtisinghe 1964) no more details were added.

A careful comparison of the figures included in this work with those given by Kirtisinghe shows that they are identical. Kirtisinghe failed to observe many details, especially the segmentation of the anterior division of the trunk and the lateral wing-like expansion of the third legs. Kirtisinghe makes no mention of the nature of the fourth legs or the shape of the egg strings. I must admit that unless one dissects the animal these may escape attention. I have no doubt that Kirtisinghe's material is the same as mine and that it cannot be placed under *Lernanthropus.*

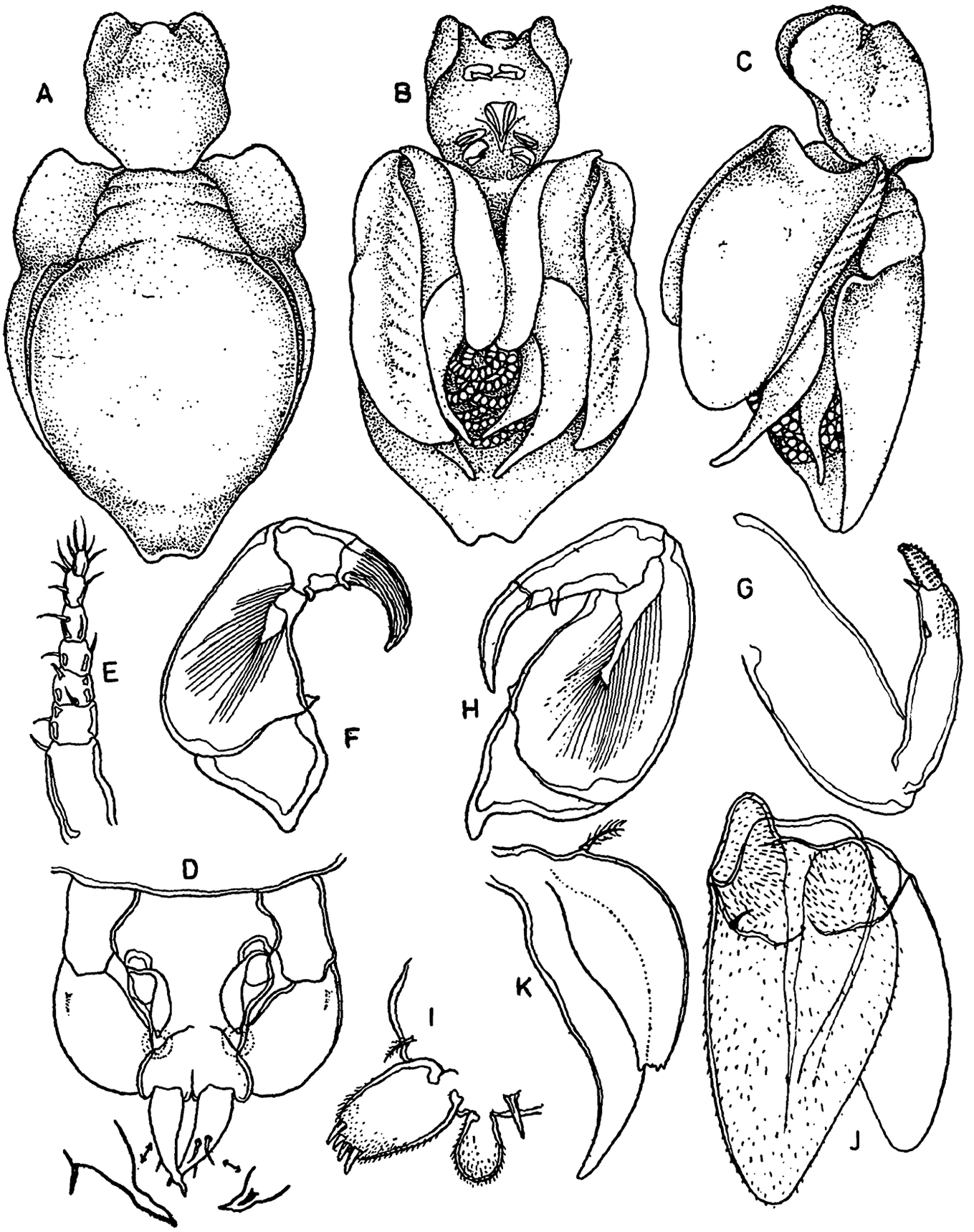


Fig. 212. *Aethon priacanthi* (Kirtisinghe) : A, female, dorsal view ; B, same, ventral view; C, same, lateral view ; D, posterior part of trunk ; E, antennule ; F, antenna ; G, maxilla ; H, maxilliped ; I, leg 1 ; J, leg 3 ; K, leg 4.

*L. larvatus* was collected from the Indian ocean and is a parasite of *Priacanthus ocellatus*. This species is very close to *L. priacanthi* and may be the same. But Heller does not give information on any of the curcial characters. For the present I leave the question of the synonymy of *L. priacanthi* open.

The male described by Kirtisinghe is unlike that of *Lernanthropus*. On the other hand it shows very close resemblance to the male of *Sagum epinepheli*. This gives additional proof that *L. priacanthi* is not a *Lernanthropus*.

*A. priacanthi* so closely resembles *A. globosus* that it can be distinguished only by very small differences. In *A. priacanthi* the cephalothorax is comparatively broader, with blunt antero-lateral lobes, the lobes of the third legs are more wing-like and the dorsal plate has a deeper posterior sinus. The distal segment of the maxilla shows different apical armature. Distal segment of the maxilliped has an accessory process which is lacking in *A. globosus*. The most important difference is in the shape of the fifth leg and the apical armature of the caudal rami. All these differences are however of the nature of intraspecific variations. *A. priacanthi* and *A. globosus* may turn out to be synonyms of *A. larvatus* (Heller).

## Genus **Sagum** Wilson

*Sagum* Wilson, 1913, p. 235 ; Yamaguti, 1963, p. 154 ; Pillai and Sebastian, 1967, p. 78 ; Hewitt, 1968b, p. 1.

*Pseudolernanthropus* Yamaguti and Yamasu, 1960, p. 146 ; Yamaguti, 1963, p. 153.

*Diagnosis.*—General shape of body as in *Lernanthropus* but broader and stouter. Cephalothorax laterally angular, lateral flaps comparatively small. Antennular lobe distinct. Anterior division of trunk short but broad, antero-laterally shoulder-like and postero-laterally produced into narrow lobes fusing with the exopods of the third legs. Dorsal plate large, as broad as anterior division of trunk. Fifth segment, genital segment and abdomen partially fused. Caudal rami large, with a basal twist making the distal part remain at right angles to the basal.

Cephalic appendages as in *Lernanthropus*. Basipods of legs one and two associated with spiny pads. Third leg biramous, rami

reaching distal border of dorsal plate, exopod fused with trunk, protopod projecting at right angles to body. Rami of fourth leg subsimilar, basal part broad, distal suddenly narrowed and whip-like. Fifth leg reduced or absent. Egg tubes coiled.

Body of male divided into cephalothorax and trunk. Antennular lobe distinct. Dorsal surface spiny. Trunk without segmentation. Abdomen distinct. Caudal rami large, with long plumose setae. Legs three and four with long whip-like spiny rami, exopods with basal outer tubercle carrying a setule. Fifth leg setiform.

Type species.—*S. flagellatum* Wilson.

*Discussion.*—Pillai and Sebastian placed under this genus *S. flagellatum* Wilson (1913), *S. angulatum* (Kroyer 1863), *S. petersi* (van Beneden 1857), *S. posteli* Delamare-Deboutteville and Nunes-Ruivo (1954b), *S. texanum* Pearse (1952) and *S. epinepheli* (Yamaguti and Yamasu 1960). Hewitt accepted our suggestion that *Pseudolernanthropus* is a synonym of *Sagum* but transferred *S. petersi*, *S. posteli* and *S. texanus* to *Paralernanthropus* alleging that in all these the egg tubes are coiled, the fourth legs are exposed in the ventral view and the exopods of the third legs are not fused with the postero-lateral extensions of the third and fourth thoracic segments.

A careful examination of the published illustrations shows that Wilson's description of the genus *Sagum* was based on very badly preserved specimens. This bad preservation has made the exopods of the third legs which are fused with the anterior division of the trunk spread out giving the animal a strange unanthosomatid shape. The same is true of the specimens of *S. posteli* figured by Delamare-Deboutteville and Nunes-Ruivo. Yamaguti and Hewitt simply repeated the erroneous description by Wilson. There is no doubt that *S. flagellatum*, *S. posteli* and *S. texanum* have exactly the same type of body as *S. epinepheli* and must be placed in *Sagum* and not *Paralernanthropus*. The only character which the latter shares with *Sagum* is the coiled egg tubes. Its third legs as described by Hewitt are totally different. Nevertheless it is doubtful whether *S. petersi* can remain in this genus. Judging from the figure of the female reproduced by Yamaguti this species has elytra-like, uniramous

third legs and segmented anterior division of trunk. It would appear that this species belongs to *Aethon*.

Only the male of *S. angulatum* has so far been described. Kroyer's figure showing the ventral view has many drawbacks but shows similarity to the male described here especially in the division of the body into cephalothorax and trunk.

*Key to species of* **Sagum**

| | | |
|---|---|---|
| 1. | Cephalothorax with large lateral lobes, dorsal surface of body tubercular | *tuberculatum* sp. nov. |
| — | Cephalothorax without large lateral lobes, dorsal side of body not tubercular | 2 |
| 2. | Dorsal surface of body smooth, dorsal plate widening backwards | *epinepheli* (Yamaguti and Yamasu) |
| — | Dorsal surface of body spinulose, dorsal plate narrowing backwards | *enneacentri* sp. nov. |

## **Sagum epinepheli** (Yamaguti and Yamasu) (Figs. 213-214)

*Pseudolernanthropus epinepheli* Yamaguti and Yamasu, 1960, p. 145, pl. 11, figs. 17-28 ; Yamaguti, 1963, p. 153, pl. 168, fig. 3.

*Sagum epinepheli* Pillai and Sebastian, 1967, p. 73, figs. 1-16.

*Female*.—Cephalothorax nearly as long as broad, postero-laterally produced into angular lobes, lateral lobes moderately deep. Anterior division of trunk gradually widening backwards, antero-laterally rounded and shoulder-like, postero-laterally prolonged into long lobes reaching beyond the middle of the dorsal plate and fused with the exopods of the third pair of legs. Dorsal plate widening backwards, posterior border even. Fourth, fifth and genital segments fused. Abdomen distinct, slightly longer than broad and much narrower than genital segment. Caudal rami basally swollen, with two proximal, one outer and two distal spine-like setae.

Antennule six to seven-segmented and sparsely setose, apical segment with several setae. Antenna stout, distal segment with a basal process, distally grooved. Inner lobe of maxillule with one

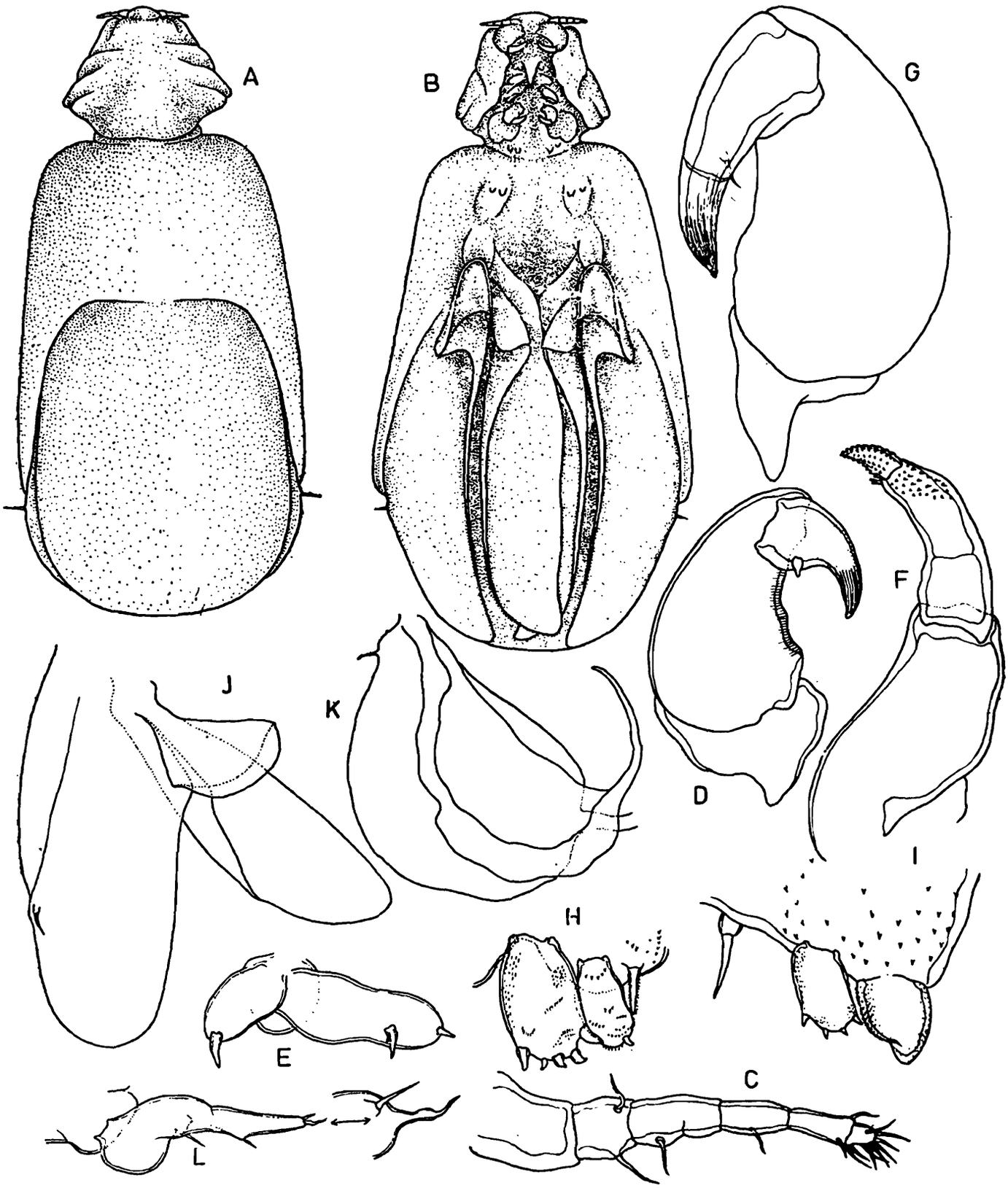


Fig. 213. *Sagum epinepheli* Pillai and Sebastian : A, female, dorsal view ; B, same, ventral view; C, antennule; D, antenna; E, maxillule; F, maxilla ; G, maxilliped ; H-K, legs 1-4 ; L, caudal ramus.

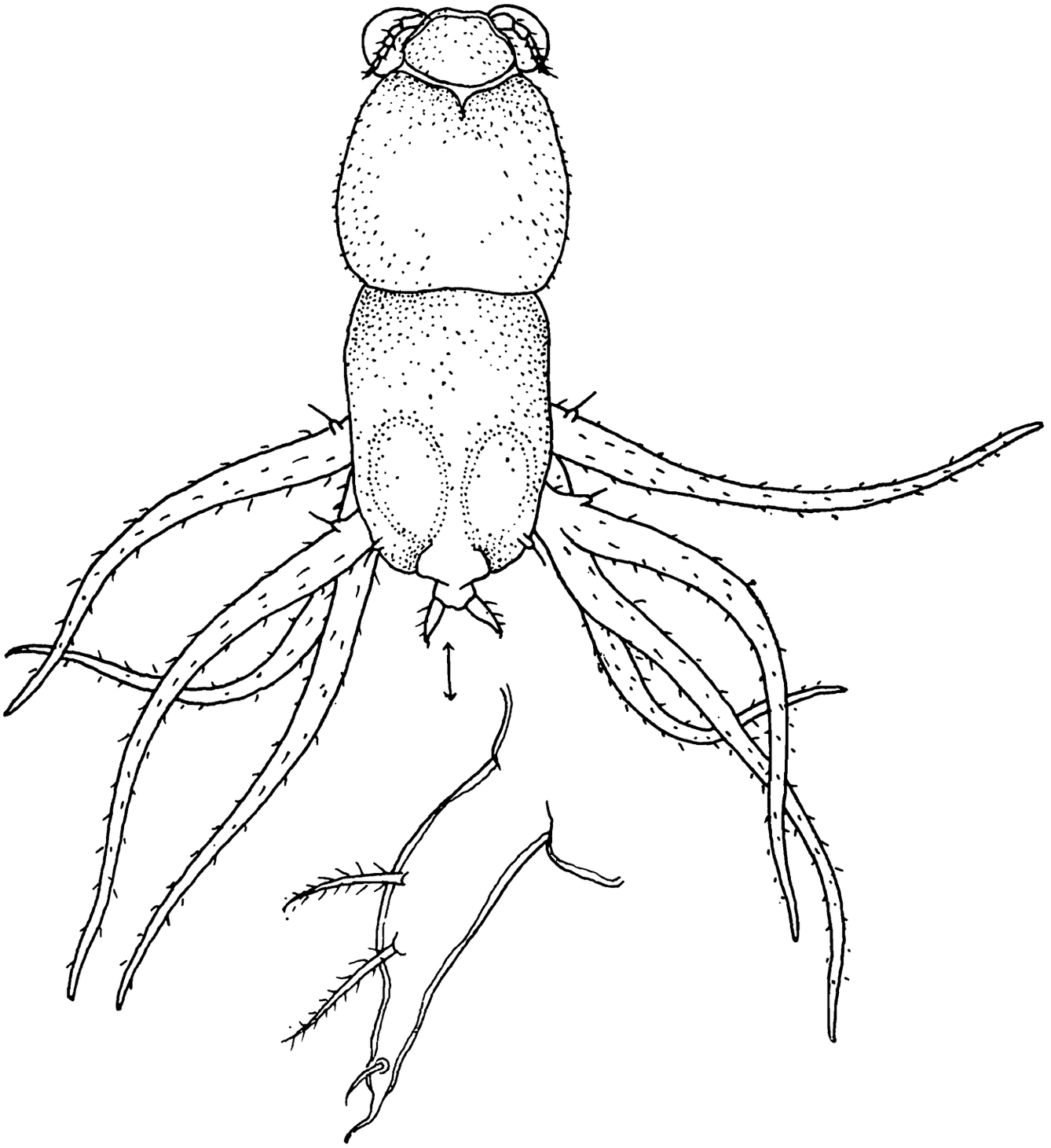

Fig. 214. *Sagum epinepheli* (contd.) ; Male, dorsal view.

and outer with two spines. Basal segment of maxilla stout, distal segment distally spiny and with a bifid process, unguis prominently spiny. Maxilliped very stout, distal segment distally grooved and chitinised.

Basipod of first leg with a few strong teeth and a barbed inner spine, exopod longer than endopod, with four large and one small spine, endopod with one spine. Basipod of second leg with outer process, exopod smaller than endopod, with four small teeth, endopod without teeth. Third leg distinctly biramous, rami subequal in length, endopods overlapping in the middle, protopod produced into a longitudinally folded projecting lobe. Fourth leg biramous, rami basally foliaceous and distally suddenly narrowed and whip-like, exopod with proximal outer seta, endopod longitudinally folded. Fifth leg apparently absent.

*Length.*—9.1 mm.

*Male.*—Body distinctly demarcated into cephalothorax and trunk, subequal in length. Cephalothorax broader than trunk and dorsally spinulose. Antennular lobe clearly demarcated by a groove. Trunk somewhat oblong. Abdomen short, clearly projecting beyond trunk. Caudal rami well developed, with two long pectinate proximal setae and two small naked distal setae. Third and fourth legs long and slender, both biramous, rami subequal and spinulose, exopod with proximal outer seta.

*Length.*—2.4 mm.

*Host.*—*Epinepheles* sp., *E. merra*, *E. akaara*.

*Distribution.*—Japan, India (Kerala).

*Remarks.*—The male described above was collected along with a female which is identical to those described by Pillai and Sebastian. Hence its identity need not be suspected. The male of *Sagum* differs from that of *Lernanthropus* mainly in the complete division of the body into cephalothorax and trunk which are subequal in size, clear demarcation of the antennular lobe and in the subsimilar third and fourth legs. These legs are clearly biramous, with subequal rami.

**Sagum enneacentri** sp. nov.
(Fig. 215)

*Female.*—Cephalothorax nearly equal in length and width, postero-laterally produced and angular but much less than in

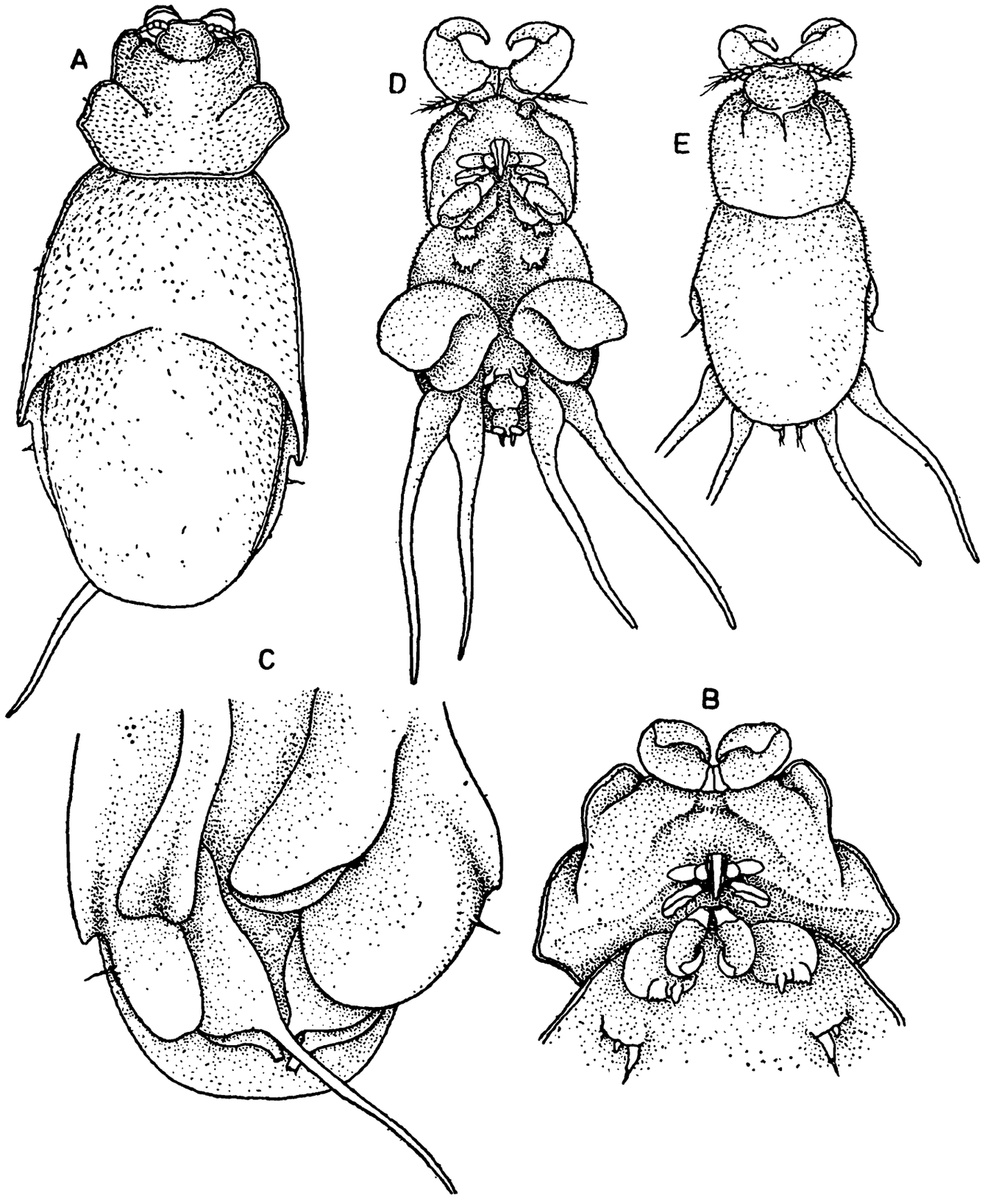


Fig. 215. *Sagum enneacentri* sp. nov. : A-C, female. A, female, dorsal view ; B, same, anterior part, ventral view ; C, posterior part, ventral view. D-E, Male. D, male, ventral view ; E, same, dorsal view.

*S. epinepheli.* Antero-lateral parts produced forwards into large rounded lobes somewhat embracing the antennular lobe. Latter rounded and clearly demarcated. Anterior division of trunk slightly broader than long, antero-laterally rounded and sloping, postero-laterally prolonged into short lobes fused with the exopods of the third legs. Dorsal plate partially demarcated from the trunk, narrowing backwards, hind border rounded. Posterior division of trunk, abdomen and caudal rami not observed.

Antennule six-jointed and moderately setose. Antennae stout and strong, shifted forwards. Lobes of maxillule comparatively short. Distal segment of maxilla with two triangular projections, unguis dentate. Maxilliped much smaller than antennae.

First leg associated with a large pad, exopod roughly squarish, with five teeth, endopod without tooth or spine. Exopod of second leg unarmed, endopod larger than exopod, with long spine. Third leg generally as in *S. epinepheli* but the rami shorter. Fourth leg biramous, rami with flattened basal and whip-like distal part. Fifth leg not observed.

*Length.*—4.8 mm.

*Male.*—Body distinctly demarcated into cephalothorax and trunk, former slightly shorter and narrower than the latter, the entire dorsal surface spinulose. Antennular lobe rounded, much narrower than rest of cephalothorax. Trunk antero-laterally rounded and slanting as in female, distal border evenly rounded.

Antennule as in female. Antenna large, placed at the anterior end. Antennular lobe with a pair of disc-like ventral pads at its base. Other cephalic appendages as in female. Third legs biramous, rami laminate and mostly hidden under trunk, exopod with outer basal seta. Fourth leg biramous, both rami with flattened base, exopod with basal outer seta. Fifth leg a small lobe with an apical seta. Genital segment and abdomen distinct. Basal part of caudal rami transversely placed, distal at right angles to the basal.

*Length.*—2.2 mm.

*Host.—Enneacentrus sonnerati.*

*Distribution.*—India (Kerala).

*Holotype and allotype.*—In the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2155/2 & C2156/2.

*Remarks.*—This species shows certain remarkable characters but in the essential details it resembles species of *Sagum.* The characters of the male are however strange. In all other anthosomatid males the third and fourth legs are slender and filiform. But in this species the third leg is foliaceous, very much like those of the female. The rami of the fourth leg are demarcated into a broad basal and narrow distal part as in female. These two appendages make one suspect that it is an immature female. But the general shape of the body is exactly like that of the male of *Sagum epinepheli.*

As I had only one male and one female I could not make a detailed study. The female is rather badly preserved.

**Sagum tuberculatum** sp. nov.
(Figs. 216-217)

*Female.*—Cephalothorax much broader than long, its lateral parts forming large lobes produced forwards and backwards. Antero-lateral parts forming two independent, comparatively small lobes clearly overreaching the antennular lobe and folding ventralwards as two small pads. Antennular lobe comparatively small. Anterior division of trunk nearly twice as broad as long, antero-laterally slanting and postero-laterally prolonged into short triangular lobes fused with the exopods of the third legs. Dorsal plate narrowing backwards, with irregular border. The whole dorsal surface strongly pustulose, pustules or spinules present on the ventral side of the wings of the cephalothorax, on the anterior division of trunk and the third legs. Fifth segment large, subequal to the genital segment. Abdomen small. Caudal rami long, nearly straight, with two proximal and one distal setae.

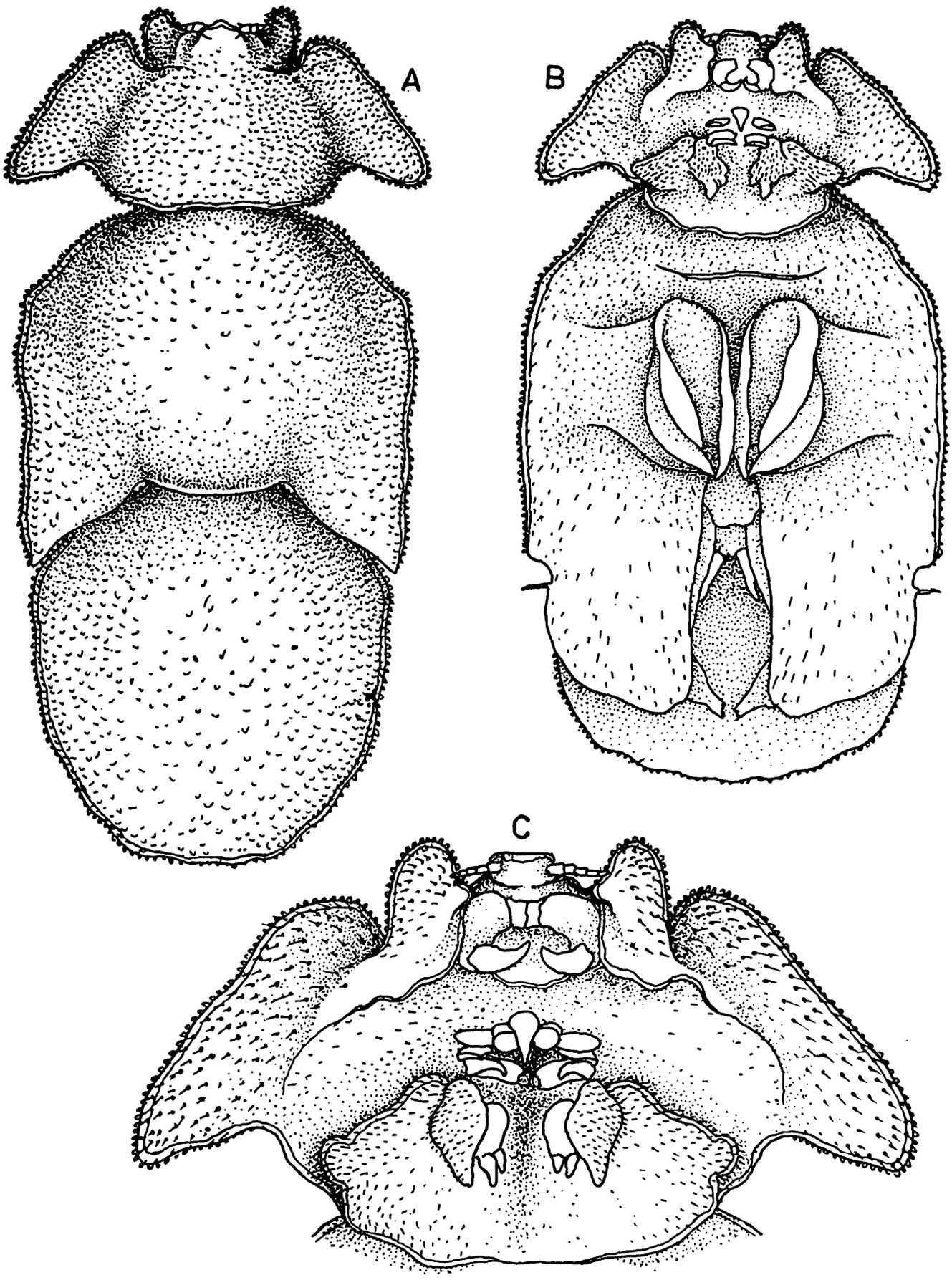


Fig. 216. *Sagum tuberculatum* sp. nov. : A, female, dorsal view ; B, same, ventral view ; C, anterior part of body, ventral view.

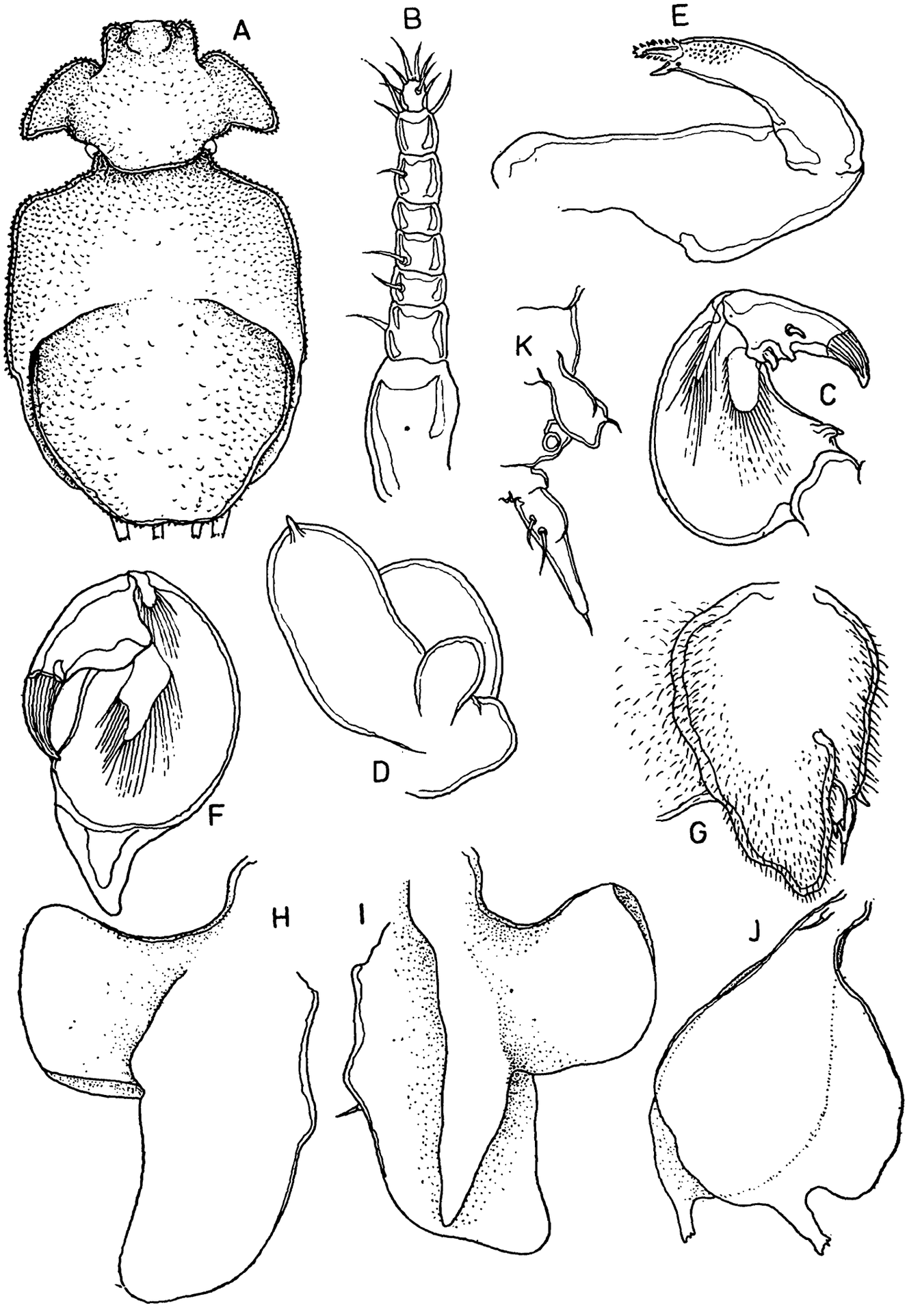


Fig. 217. *Sagum tuberculatum* (contd.) : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxillule ; E, maxilla ; F, maxilliped ; G, leg 1 ; H-I, leg 3 ; J, leg 4 ; K, posterior part of trunk.

Antennule eight-jointed, sparsely setose, apical segment with about seven setae. Antennae stout, flanged by the ventral foldings of the antero-lateral lobes of the cephalothorax, basal segment with one large process, distal with two. Inner lobe of maxillule very small, outer with one apical spine. Basal segment of maxilla large, distal with a distal patch of teeth and a process, unguis small, indistinct, bilaterally dentate. Maxilliped smaller than antennae, distal segment well curved, basally enlarged.

First leg associated with a large spiny pad, basipod externally enlarged and hirsute, produced backwards into a hirsute conical lobe, exopod with two and endopod with one spine, basipod with short outer process. Second leg not observed. Third leg apparently biramous but the endopod much reduced, exopod elytra-like, very much as in *Norion*, protopod longitudinally folded and projecting. Fourth leg biramous, rami with broad basal and whip-like distal part. Fifth leg a small lobe with a seta.

*Length.*—5.6 mm.

*Host.*—*Lutianus* sp.

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2157/2.

*Remarks.*—This bizzare copepod can be easily identified by the shape of the cephalothorax and the highly tubercular nature of the body.

A curious feature one notices is that anthosomatids parasitic on perches have their body invariably covered with pustules, tubercles or spinules. This is so irrespective of the genus to which a particular species belongs. See for example *L. brevicephalus*, *A. priacanthi* and *S. tuberculatum*.

## Family EUDACTYLINIDAE

*Diagnosis.*—Cephalon fused with first thoracic segment to form a cephalothorax, following three or four thoracic segments free.

Fifth segment often fused with genital segment, latter sometimes very long. Abdomen one to three-segmented. Caudal rami cylindrical or laminate, with spines or setae or both.

Antennule cylindrical or flattened, with or without strong spines. Antenna claw-like or chelate. Maxilliped claw-like or chelate. Legs one to four biramous, rami two or-three segmented, with spines, setae or both. Fifth leg uniramous.

Gill parasites of elasmobranchs.

Type genus.—*Eudactylina* van Beneden.

*Discussion.*—Yamaguti included eight genera in this family, namely, *Lamproglena*, *Kroyeria*, *Kroyerina*, *Congericola*, *Nemesis*, *Eudactylina*, *Eudactylinodes* and *Eudactylinella*. Since then two more genera, *Eudactylinopsis* Pillai and *Bariaka* Cressey were added. Only five of these genera have been recorded from Indian waters.

*Key to genera of* EUDACTYLINIDAE

| | | |
|---|---|---|
| 1. | Antenna chelate | **Kroyeria** van Beneden |
| — | Antenna claw-like | .2 |
| 2. | Rami of legs two-jointed | **Nemesis** Risso |
| — | Rami of legs three jointed | .3 |
| 3. | Antennule with claws or spines | **Eudactylina** van Beneden |
| — | Antennule without claws or spines | .4 |
| 4. | Body short, abdomen two-jointed, legs without setae | **Eudactylinopsis** Pillai |
| — | Body long, abdomen four-jointed, legs with setae | **Bariaka** Cressey |

## Genus **Eudactylinopsis** Pillai

*Eudactylinopsis* Pillai, 1968b, p. 31.

*Diagnosis.*—Body long and cylindrical, cephalothorax with dorsal side sclerotised and transversely wrinkled. Thoracic segments two

and three short, dorsal side similar to that of cephalothorax, fourth and fifth segments large, dorsal surface longitudinally wrinkled. Genital segment small, partially fused with fifth segment. Abdomen short, two-segmented.

Antennule without spines. Antenna without strong processes. Maxillule and maxilla as in *Eudactylina*. Basal segment of masilliped with stout process making it chelate. Legs one to four with three-jointed rami, not setose.

Cephalothorax of male with four posterior processes. Thoracic segments short, narrowing. Genital segment large. Abdomen long, four-jointed. Caudal rami with plumose setae. Antennule slender. Antenna also slender, distal segment claw-like. Maxilliped slender, not chelate. Legs one to four with three-jointed setose rami.

Type species.—*E. curvatus* Pillai.

### **Eudactylinopsis curvatus** Pillai
(Figs. 218-219)

*Eudactylinopsis curvatus* Pillai, 1968b, p. 82, figs. 10-11.

*Female*.—Body cylindrical, almost of uniform width. Cephalothorax long ovate. Second thoracic segment broader than long, third nearly as long as broad, fourth large, longer than broad, fifth longer and narrower than fourth. Genital segment very small, partially fused with fifth segment. Abdomen short, two-jointed, with spiny surface. Caudal rami oblong, with four spines and two setae, surface spiny.

Antennule stout, narrowing, not demarcated into peduncle and flagellum, setose and not spiny. Antenna short but stout, four-segmented, second segment with an inner seta. Maxillule two-lobed, each lobe with two spines. Maxilla robust, basal segment very stout, second broadening, distal inner part bulged and spiny, outer part with a bunch of hairs, claw with two rows of spinules. Maxilliped stout but short, basal segment produced into a conical process which together with the distal segment produces a chela, tip of distal segment forked and with an inner spine.

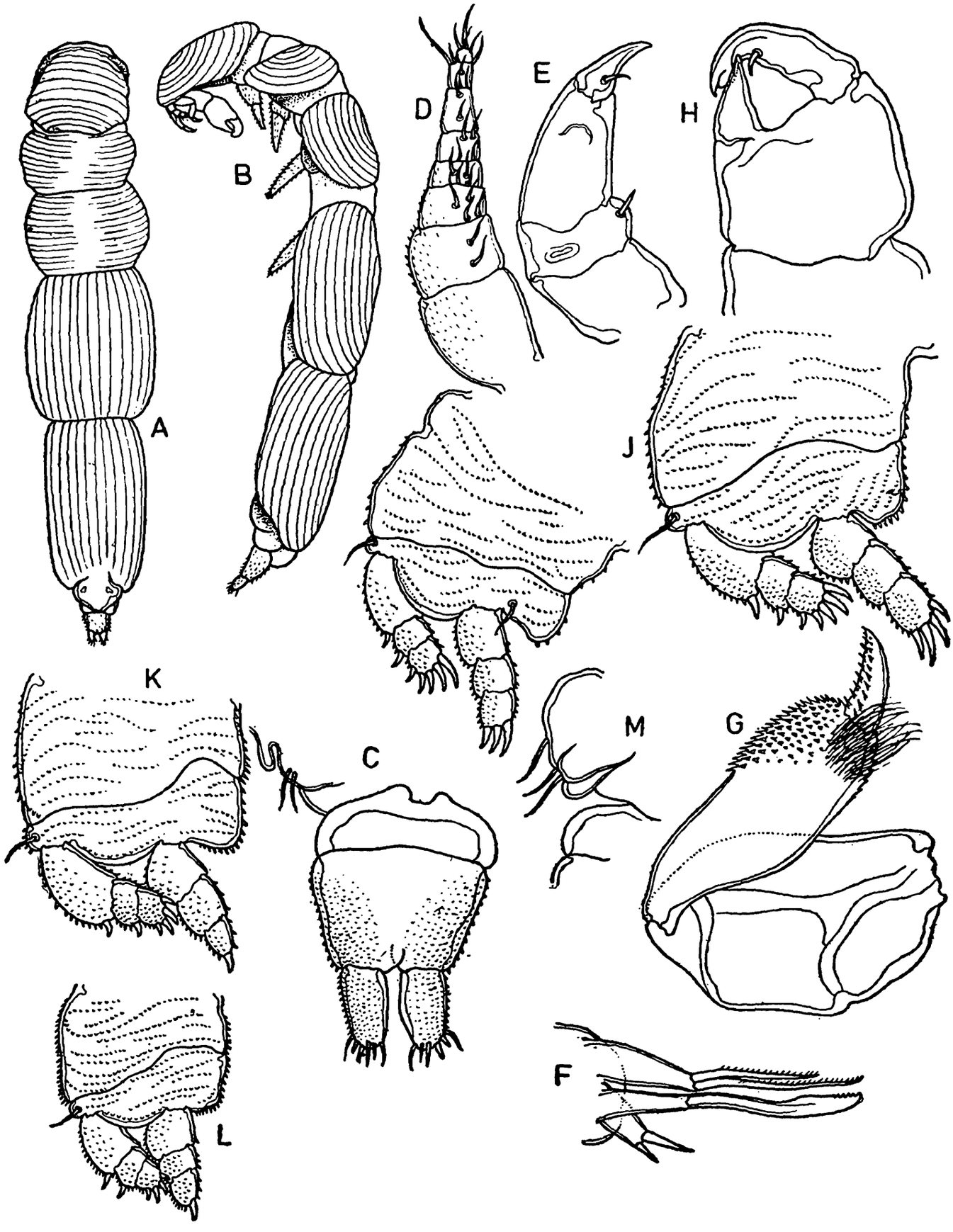


Fig. 218. *Eudactylinopsis curvatus* Pillai : A, female, dorsal view ; B, same, lateral view ; C, posterior part of body ; D, antennule ; E, antenna ; F, mandible and maxillule ; G, maxilla ; H, maxilliped.

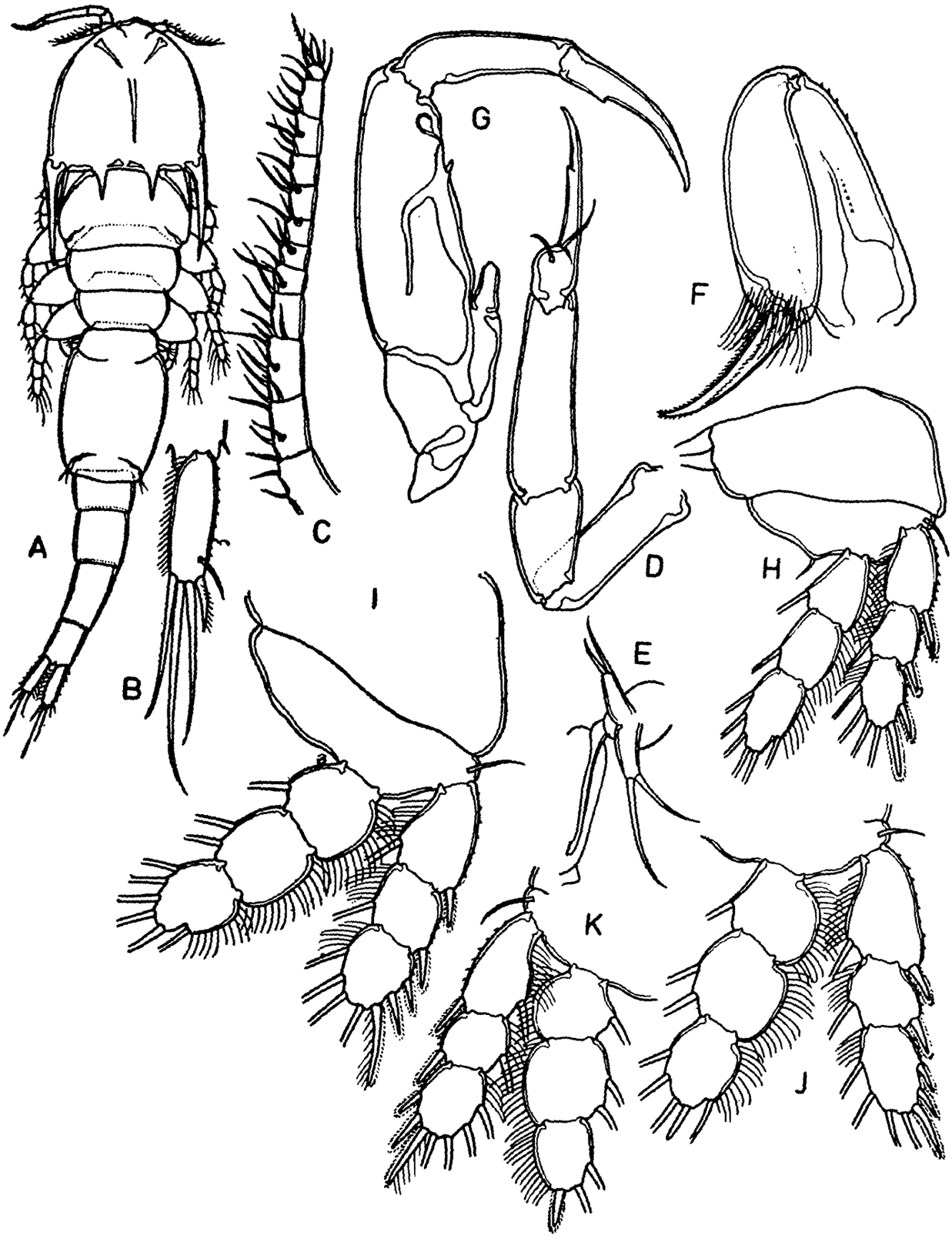


Fig. 219. *Eudactylinopsis curvatus* (contd.) : A, male, dorsal view ; B, caudal ramus ; C, antennule ; D, antenna ; E, mandible and maxillule ; F, maxilla; G, maxilliped ; H-K, legs 1-4.

Basipods of legs one to four squarish, with irregular transverse rows of tubercles, rami slender, three-jointed, covered with tubercles and armed with short but strong spines.

*Length.*—3.3 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 0+0, III | 0+I, 0+I, V |
| Leg 2 | 0+0, 0+0, IV | 0+I, 0+I, V |
| Leg 3 | 0+0, 0+0, I | 0+I, 0+I, IV |
| Leg 4 | 0+0, 0+0, I | 0+I, 0+I, IV |

*Male.*—Cephalothorax anteriorly rounded, posteriorly transverse and with a pair of long lateral and a pair of short submedian spines or processes. Second thoracic segment short, third and fourth narrower than second, fifth small, partially fused with genital segment, latter much broader than fifth segment and longer than broad. Abdomen long and slender, four-segmented, third segment longest. Caudal rami about three times as long as broad, subequal to anal segment in length, with three long apical setae.

Antennule long and slender, twelve-segmented and setose. Antenna four-segmented, third segment long, fourth a long slightly curved claw with swollen base carrying two setae. Mixilliped not chelate, basal segment with proximal process, distal segment with median partition, very long and curved.

Basipods of legs not spiny, rami three-segmented, with blunt flanged spines and plumose setae. Fifth leg a small lobe carrying three short setae.

*Length.*—2.3 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 1+0, 6 | 0+I, 1+I, 4+II |
| Leg 2 | 1+0, 2+0, 6 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 2+0, 3+I+1 | 1+I, 1+I, 4+III |
| Leg 4 | 1+0, 2+0, 2+I | 1+I, 1+I, 4+III |

*Host.*—*Pristis* sp.

*Distribution.*—India (Kerala).

*Types* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2158/2 ; C 2159/2.

*Remarks.*—In the nature of the appendages, particularly the cephalic, this species shows close resemblance to *Bariaka alopiae* Cressey but differs in the shape of the body and the nature of the legs.

## Genus **Bariaka** Cressey

*Bariaka* Cressey, 1966b, p. 324.

*Diagnosis.*—Body elongated and wormiform, without distinct segmentation. Cephalon fused with first thoracic segment forming a cephalothorax not much broader than the free thoracic segments, segments two to five free but indistinctly demarcated. Genital segment small but distinct. Abdomen short, four-segmented. Caudal rami small.

Antennule sixteen to seventeen-segmented, not demarcated into peduncle and flagellum, without spines. Antenna four-segmented, claw-like. Maxillule and maxilla as in *Eudactylina.* Maxilliped prehensile. Legs one to four with three-jointed rami, with short setae and stout spines. Leg five lobe-like, with setae.

Thoracic segments of male short, abdominal segments long. Caudal rami large. Appendages as in female. Legs one to four with long setae, leg six present.

Type spccies.—*B. alopiae* Cressey.

*Discussion.*—This genus is most closely related to *Eudactylinopsis* Pillai. Both have a cylindrical worm-like body devoid of spines. In both the antennule is devoid of spines and is not demarcated into peduncle and flagellum. The antenna lacks stout spines. The basal segment of the maxilliped has a large process and the legs are armed with conspicuous teeth. However *Bariaka* can be easily distinguished from *Eudactylinopsis* by the presence of setae on the legs.

## **Bariaka alopiae** Cressey
(Figs. 220, 221A-D.)

*Bariaka alopiae* Cressey, 1966b, p. 324, figs. 1-2.

*Female.*—Cephalothorax slightly longer than broad and broader than the thoracic segments, segments two to five indistinctly demarcated. Genital segment completely fused with fifth thoracic segment, ventro-laterally produced into lobes. Abdomen four-segmented and slender, segmentation indistinct. Caudal rami very small, with three setae and three blunt spines, attached to ventral side of abdomen.

Antennule fifteen to sixteen-segmented, regularly narrowing, armed with slender setae. Antenna four-segmented, narrowing distalwards, second segment with an inner tubercle carrying two spines, third segment with small tubercles, fourth with broad base carrying two setae, distal part claw-like. Inner lobe of maxillule short, with one long and two small spines, outer lobe with two long subsimilar spines. Basal segment of maxilla as long as distal but stouter, latter distally with a lobe covered with hairs, claw strong. Maxilliped very large, proximal inner part of its basal segment with a large sharp spine, distal segment long, with curved median inner process and a lower distal process consisting of a stout base and sculptured distal spine, the segment suddenly narrowed beyond this process.

Basipods of legs one to four with conspicuous spines, rami three-jointed and externally spiny. Exopod segments one and two with outer stout spines, third with outer spines and inner setae, endopod segments produced into spines as in *Nemesis*, without setae. Fifth leg a semicircular lobe with three setae.

*Length.*—9.4 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 0+0, 3 | 0+I, 1+I, 5+II |
| Leg 2 | 0+0, 0+0, 1 | 0+I, 0+I, 4+III |
| Leg 3 | 0+0, 0+0, I | 0+I, 0+I, 3+II |
| Leg 4 | 0+0, 0+0, I | 0+I, 0+I, 2+III |

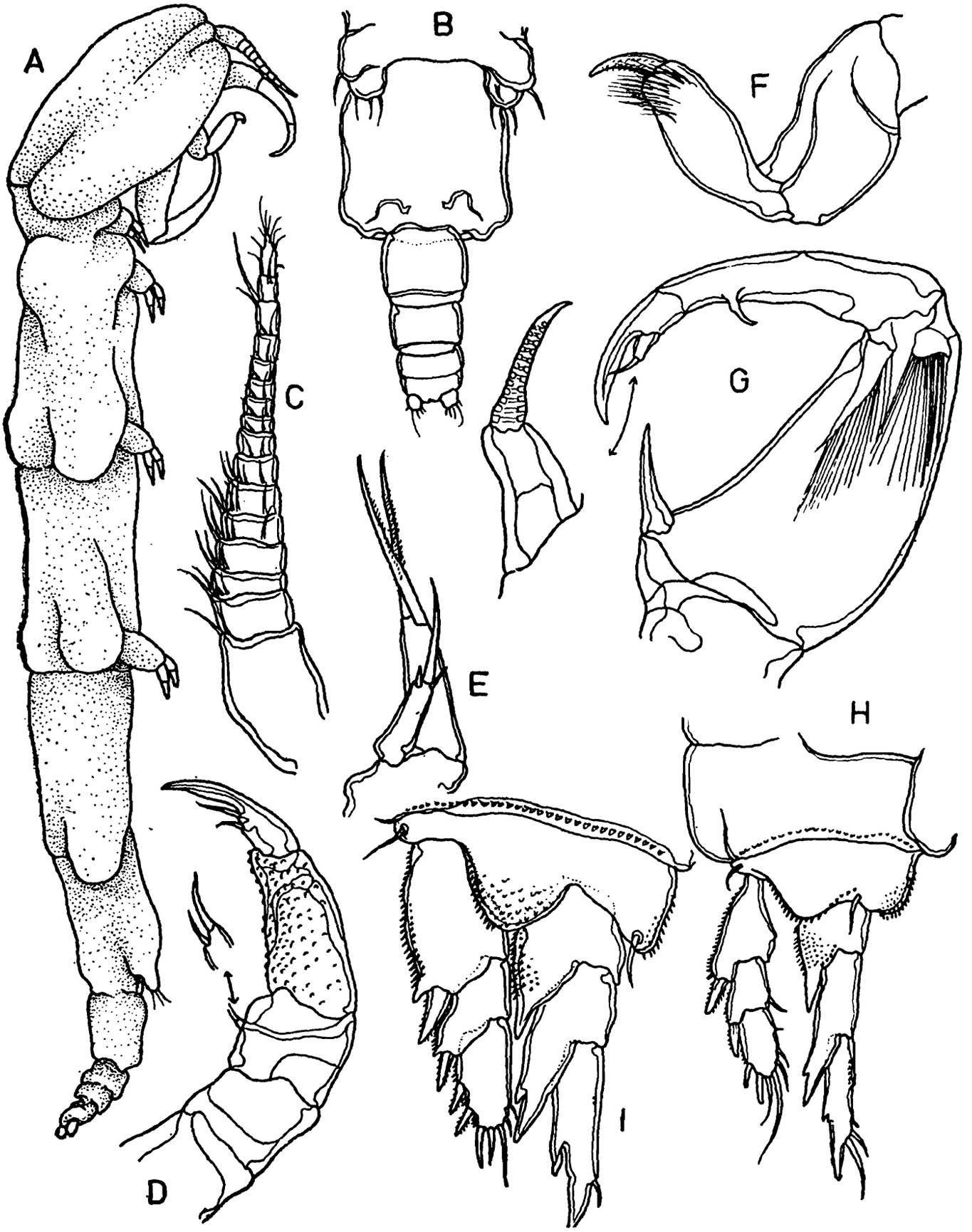


Fig. 220. *Bariaka alopiae* Cressey : A, female, lateral view ; B, posterior part of body ; C, antennule ; D, antenna ; E, maxillule ; F, maxilla ; G, maxilliped ; H-I, legs 1-2.

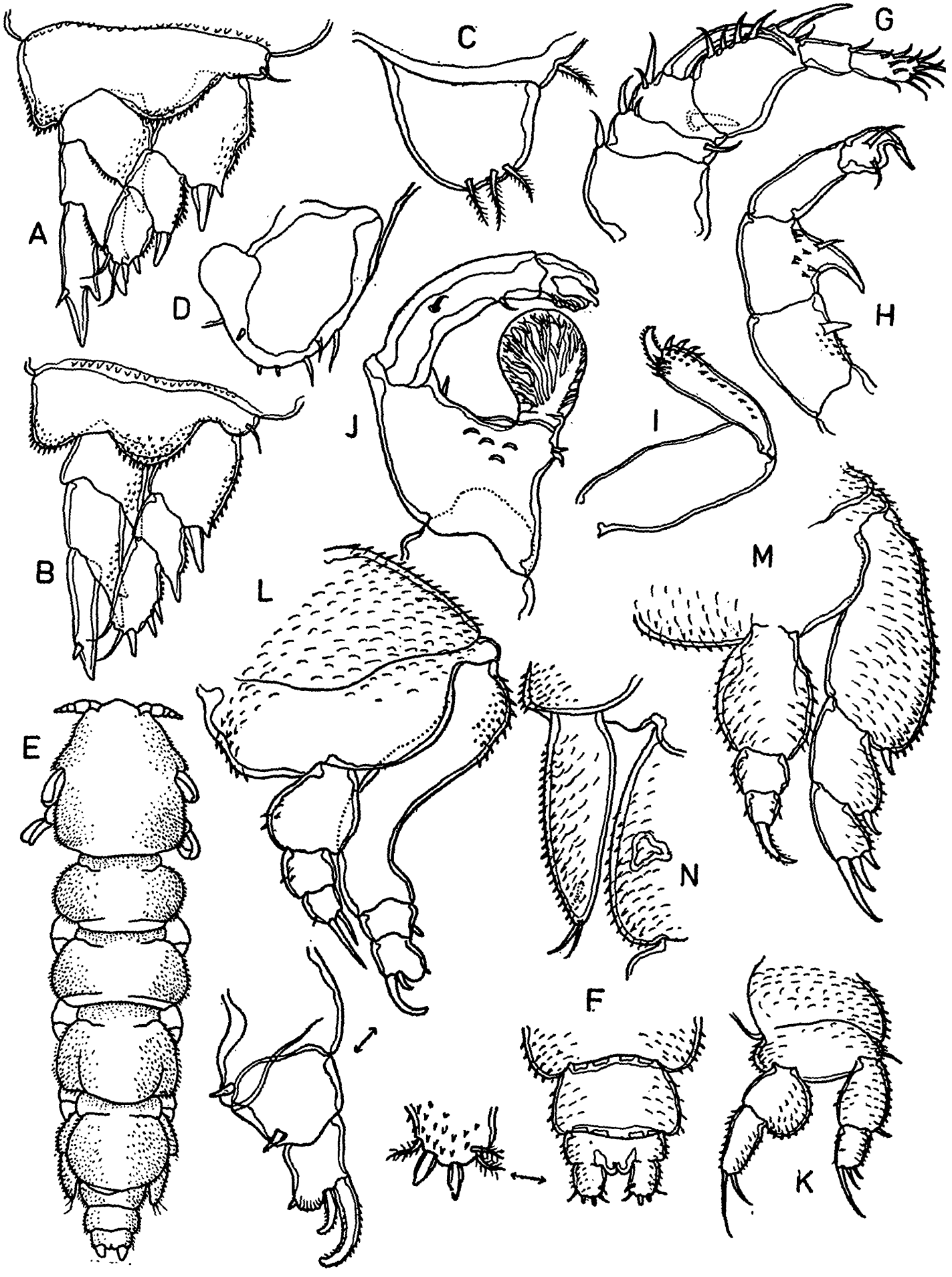


Fig. 221. *Bariaka alopiae* (contd.) : A-C, legs 3-5 ; D, caudal ramus. E-N ; *Eudactylina aspera* Heller : E, female, dorsal view ; F, posterior part of body ; G, antennule ; H, antenna ; I, maxilla ; J, maxilliped ; K, leg 1 ; L, leg 2 ; M, leg 3 ; N, leg 5.

*Male.*—Cephalothorax large, one fourth the total length, thoracic segments comparatively short, with the dorsal side sclerotised. Abdomen long and four-segmented. Caudal rami much longer than broad, with four very long plumose setae and two small naked setae. Cephalic appendages as in female. Legs with three-jointed rami, slightly different from those of female, rami with outer spines and long plumose inner setae, spines with serrate flange.

*Length.*—5.8 mm.

*Host.*—*Alopias superciliosus.*

*Distribution.*—Indian ocean (Madagascar), Pacific ocean.

*Type.*—In the U.S. National Museum.

*Remarks.*—Compared to the original description the specimen I studied had a smaller number of antennular segments. The last antennal segment has two instead of one spine. Maxilla has a small lobe on the distal segment. The thoracic segments of the female are more clearly marked and the dorsal side shows slightly more sclerotisation.

## Genus **Eudactylina** van Beneden

*Eudactylina* van Beneden, 1853, p. 235 ; Yamaguti, 1963, p. 157.

*Diagnosis.*—Cephalothorax longer than broad, antero-laterally constricted and often with lobes. Thoracic segments two to five free. Genital segment smaller than fifth segment.

Abdomen short, two-jointed. Caudal rami flattened, with setae. Egg tubes short, with a small number of eggs. Dorsal side of body segments generally sclerotised and with scale-like processes appearing as spines.

Antennule demarcated into peduncle and flagellum, usually with large spines. Antenna four-jointed, with strong processes, terminal segment claw-like. Maxillule bifid. Maxilla two-jointed, second segment armed with spines or tubercles and a bunch of hairs, unguis

spiny. Maxilliped chelate. Legs one to four biramous, rami of first two or three-jointed, of others three-segmented, exopod of second leg often highly modified, endopod of third and fourth legs two or even one-segmented. Fifth leg a small setose lobe.

Body of male long and slender, dorsum not chitinised or spiny. Genital segment large. Abdomen large, three to four-segmented. Caudal rami with plumose setae. Maxilla with slender distal segment. Maxilliped not chelate. Exopod of legs one to four three-jointed, with plumose setae, endopods one or two-segmented.

Type species.—*E. acuta* van Beneden.

*Key to species of* **Eudactylina**

| | | |
|---|---|---|
| 1. | Second thoracic segment produced into large wings or lobes | *.alata* Pillai |
| — | Second thoracic segment normal | .2 |
| 2. | Exopod of second leg not modified | .3 |
| — | Exopod of second leg modified | .4 |
| 3. | Rami of legs subequal in size, antennule with small spines | *.pollex* Cressey |
| — | Rami of legs unequal, antennule with long spines | *.olivieri* Laubier |
| 4. | Rami of first leg three-jointed | *.pusilla* Cressey |
| — | Rami of first leg two-jointed | .5 |
| 5. | Antenna with small spines on first two segments | *.aspera* Heller |
| — | Antenna without small spines on first two segments | *.lancifera* Pillai |

## **Eudactylina aspera** Heller
(Fig. 221 E-N)

*Eudactylina aspera* Heller, 1868, p. 213, pl. 21, fig. 1 ; Bere, 1936, p. 604, pl. 8, figs. 185-196 ; Yamaguti, 1963, p. 158, pl. 183, fig. 1 ; Cressey, 1967b. p. 8 ; 1970, p. 15, fig. 58 ; Kabata, 1970b, p. 164, fig. 2.

*Female.*—Cephalothorax comparatively large, longer than broad, anterior border trilobed, lateral borders with a very prominent incision overhung by a conical anterior prolongation, posteriorly broadest. Thoracic segments two to four subequal in size, each with short anterior neck, dorsal side with prominent transversely

oblong chitinisation projecting laterally. Fifth segment also chitinised dorsally but narrower than fourth. Genital segment much narrower than fifth segment, as long as broad. Abdomen two-segmented, first segment longer than second. Caudal rami slightly longer than broad, with three setae and two blunt spines. The entire dorsal surface of the body scaly, scales more prominent laterally.

Antennule six-segmented, third segment with a short outer and a long curved distal spine and fourth with a distal straight spine. Antenna four-jointed, basal segment with one large and several small spines, second with a stout claw-like process and a patch of spines, third naked, fourth with swollen base carrying two spines, distal part curved. Distal segment of maxilla slender, with a longitudinal row of large spines and a patch of hairs, claw short, spiny. Basal segment of maxilliped with one distal and two inner spines, inner distal part produced into a rounded process, distal segment long, equally broad throughout, with two spines, apex bifid, ventral part irregularly lobed.

First leg small, with subequal two-jointed rami. Endopod of second leg three-jointed, basal segment swollen, exopod modified, basal segment long and double curved, distal two segments as in figure. Third and fourth legs with three-jointed rami, exopod larger and armed with strong spines. Fifth leg a large lamina.

*Length.*—1.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, II | 0+I, III |
| Leg 2 | 0+0, 0+0, II | 0+I, 0+I, III |
| Leg 3 & 4 | 0+0, 0+0, I | 0+I, 0+I, III |

*Host.—Carcharias pleurotaenia, C. maculipinnis, Chiloscyllium punctatum, Rhizoprionodon acutus, Sphyrna lewini, Scoliodon terrae-novae, Aprionodon isodon, Carcharhinus limbatus.*

*Distribution.*—Java, Gulf of Mexico, Madagascar, Australia, Florida.

## **Eudactylina pusilla** Cressey
(Figs. 222, 223)

*Eudactylina pusilla* Cressey, 1967b, p. 9, figs. 3, 2-30 ; 1970, p. 15, figs. 55-56.

*Female.*—Cephalothorax triangular, anteriorly trilobed, antero-laterally with large lobes, postero-laterally bulging. Segments two to four broader than long, with chitinised dorsum bulging laterally. Fifth segment shorter and narrower than fourth, transversely oblong. Genital segment large, roughly rounded, much narrower than fifth segment. Abdomen small, two-segmented, first segment broader than second. Caudal rami with two setae and three stout spines.

Peduncle of antennule rather stout, with comparatively short spines, third segment with a proximal outer large curved spine. Antenna stout, second segment with a conical inner process carrying a setule, fourth segment with two small and one large spine. Mandible distally not narrowed, with five blunt teeth. Inner lobe of maxillule with one small and one long spine, outer lobe with prominent outer spines, distal spines long, all the long spines barbed. Maxilla rather stout, second segment prominently spiny, bulge absent, bunch of hairs replaced by spines, claw long and naked. Basal segment of maxilliped broader than long, prolonged into an apically hollowed digitiform process, distal segment stout and curved, with four stout spines and a subapical cup-like expansion.

First leg with three-jointed rami, exopod smaller, endopod with long barbed apical spine. Endopod of second leg short, exopod modified, basal segment much longer than rest of limb, distal inner part expanded, distal segment with four spines. Rami of third and fourth legs subsimilar and three-jointed, exopod with strong claws, endopod with stout apical spine. Fifth leg basally bulged.

*Length.*—4.6 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 0+0, II | 0+I, 0+I, III |
| Leg 2 | 0+0, 0+0, II | I+I, 0+0, IV |
| Leg 3 | 0+0, 0+0, I | 0+I, 0+I, III |
| Leg 4 | 0+0, 0+0, I | 0+I, 0+I, III |

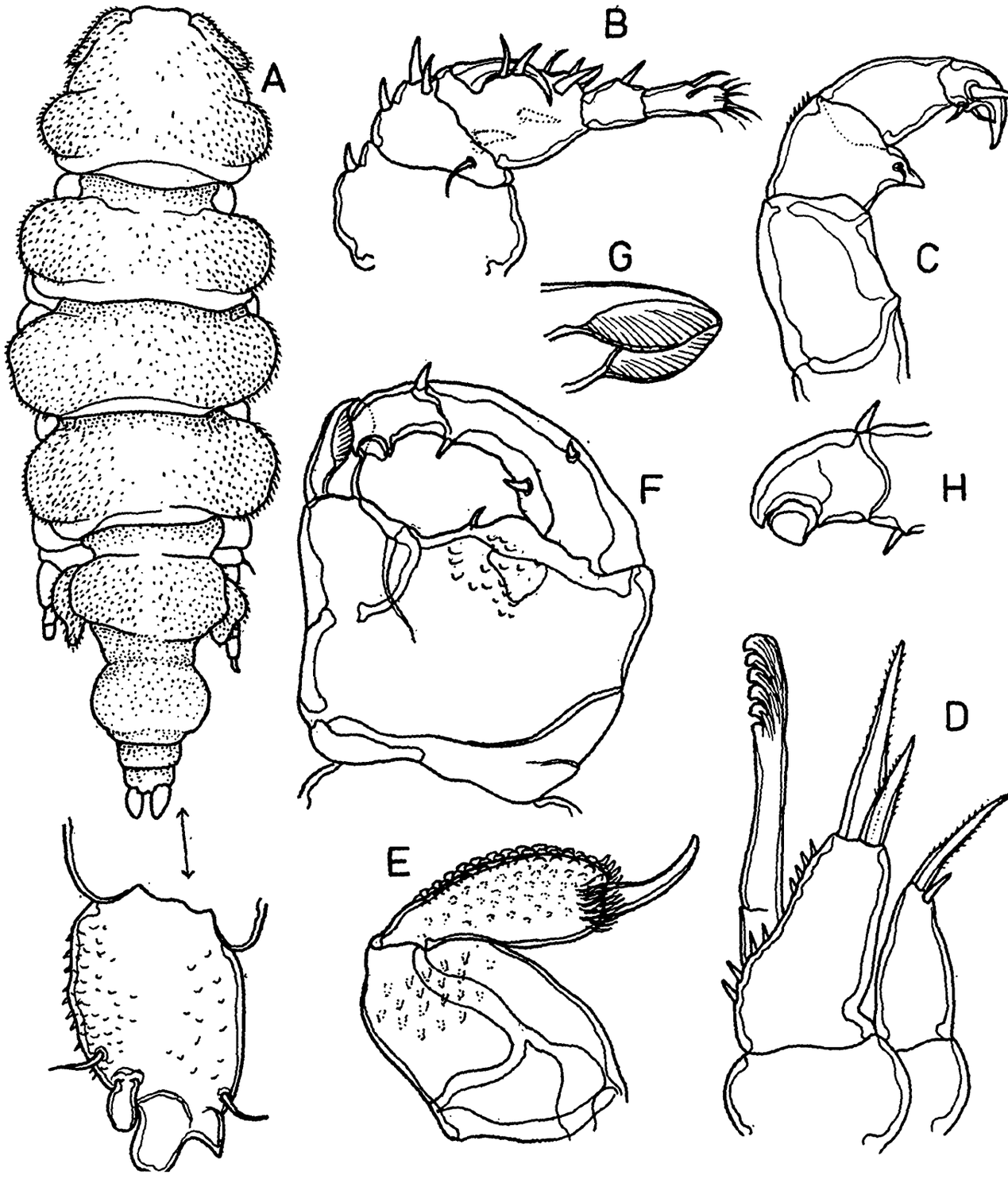


Fig. 222. *Eudactylina pusilla* Cressey : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible and maxillule ; E, maxilla ; F, maxilliped ; G, same, tip of inner process ; H, tip of distal segment.

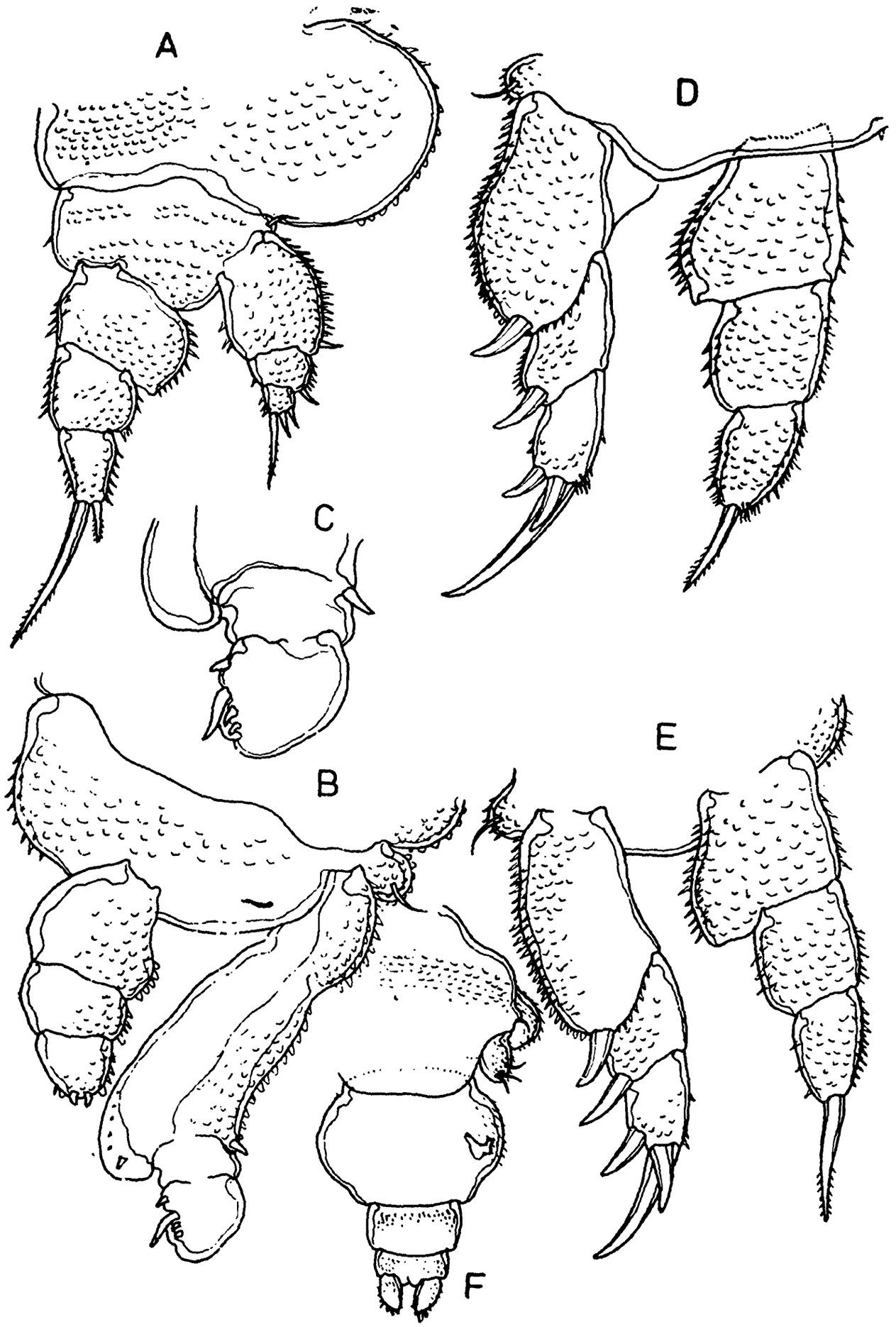


Fig. 223. *Eudactylina pusilla* (contd.) : A, leg 1 ; B, leg 2 ; C, same, tip of exopod ; D, leg 3 ; E, leg 4 ; F, posterior part of body.

*Host.*—*Galeocerdo cuvieri.*

*Distribution.*—Madagascar, Florida.

*Type* in the U. S. National Museum.

*Remarks.*—Compared to Cressey's description the caudal rami are spinulose and have an additional spine. The spines on the maxillule are barbed. The distal segment of the maxilliped has four spines.

## **Eudactylina pollex** Cressey
(Fig. 224)

*Eudactylina pollex* Cressey, 1967b, p. 11, figs. 4, 31-42 ; 1970, p. 15, figs. 52-53.

*Female.*—Body elongated and slender, narrowing backwards. Cephalothorax slightly longer than broad, anteriorly subtruncate, antero-lateral parts forming large lobes followed by a small constriction. Second thoracic segment with anterior neck, third broader than second, fourth longer than third, fifth narrower than fourth, all the segments with the dorsum feebly sclerotised and spiny. Genital segment longer than abdomen, latter two-segmented. Caudal rami longer than broad, slightly narrowing backwards, with a proximal outer and two distal setae and two small spines and two long claws on distal border.

Antennule rather stout, not clearly demarcated into peduncle and flagellum, armed with short spines except at the tip. Antenna moderately stout, segments one to three with small spinules, second with small inner median projection carrying two spines, fourth segment with two short spines and a large spine. Maxilla almost throughout spiny, distal segment with inner and distal row of strong spines, claw bilaterally barbed. Basal segment of maxilliped externally spiny, internally produced into a large process, apically flattened, distal segment with inner spine, apex disc-like.

Basipod of first leg very large, externally strongly spiny, exopod three-jointed, first segment long, with outer row of long spines, other segments with strong claws, endopod two-jointed. Both rami

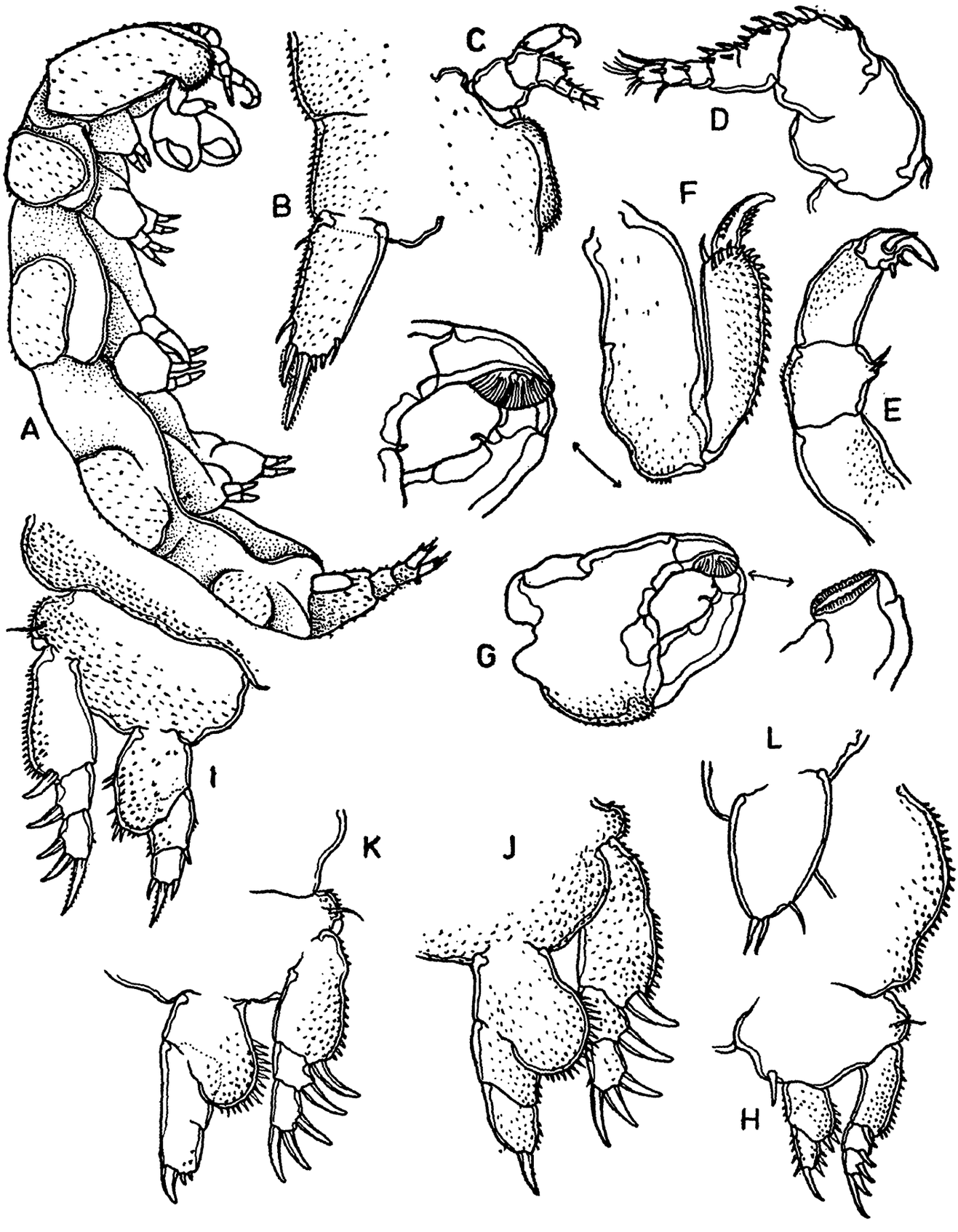


Fig. 224. *Eudactylina pollex* Cressey : A, female, lateral view ; B, posterior part of body ; C, cephalothorax ; D, antennule ; E, antenna ; F, maxilla ; G, maxilliped ; H-L, legs 1-5.

of second leg three-jointed, basal segment of endopod enlarged, exopod not modified. Third leg similar to second, basal segment of endopod more enlarged than in the second leg. Exopod of fourth leg similar to that of third, endopod with indistinct segmentation, third segment with a short stout claw. Fifth leg laminate, with three spine-like setae.

*Length.*—3.6 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+I, I | 0+I, 0+I, III |
| Leg 2 | 0+0, I+0, III | 0+I, 0+I, III |
| Leg 3 | 0+0, 0+0, I | 0+I, 0+I, III |
| Leg 4 | 0+0, I | 0+I, 0+I, III |

*Host.—Sphyrna mokarran.*

*Distribution.*—Madagascar, Florida.

*Type* in the U. S. National Museum.

*Remarks.*—This species has several very diagnostic characters, namely the absence of long spines on the antennule, the absence of strong processes on the second segment of the antenna, the strongly armed rami of the legs and the incomplete segmentation of the endopod of the fourth leg. The absence of modification of the exopod of the second leg is also characteristic.

## **Eudactylina olivieri** Laubier
(Figs. 225-226)

*Eudactylina olivieri* Laubier, 1968, p. 159, figs. 1-3.

*Female.*—Cephalothorax antero-medially produced between the antennules, antero-laterally produced into small processes followed by a fairly deep constriction. Second thoracic segment anteriorly as broad as cephalothorax, posteriorly rounded and narrower, third segment antero-laterally bulged, posteriorly rounded and overlapping fourth segment. Fourth segment nearly as broad as

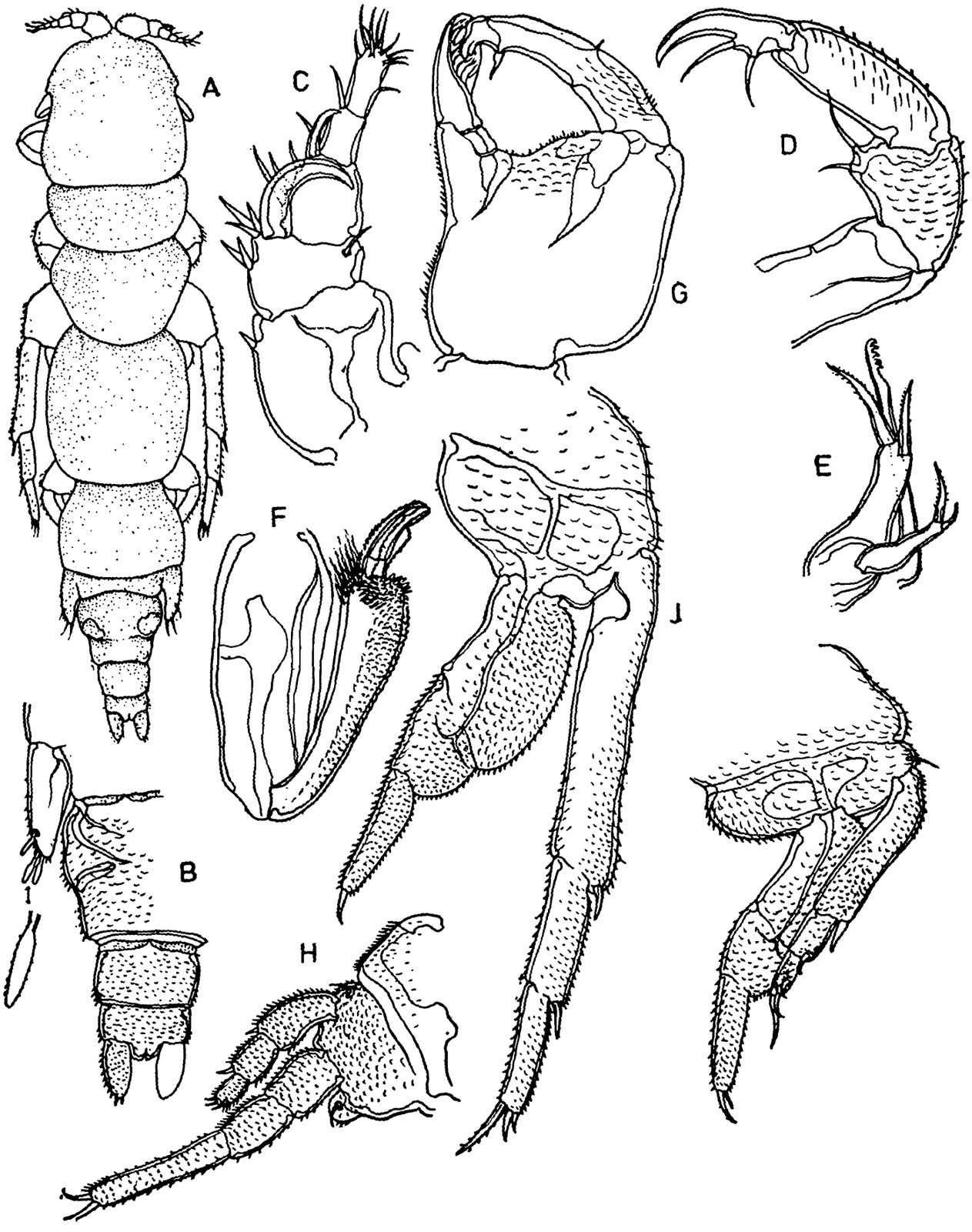


Fig. 225. *Eudactylina olivieri* Laubier : A, female, dorsal view ; B, posterior part of body ; C, antennule ; D, antenna ; E, mandible and maxillule ; F, maxilla ; G, maxilliped ; H-J, legs 1-3

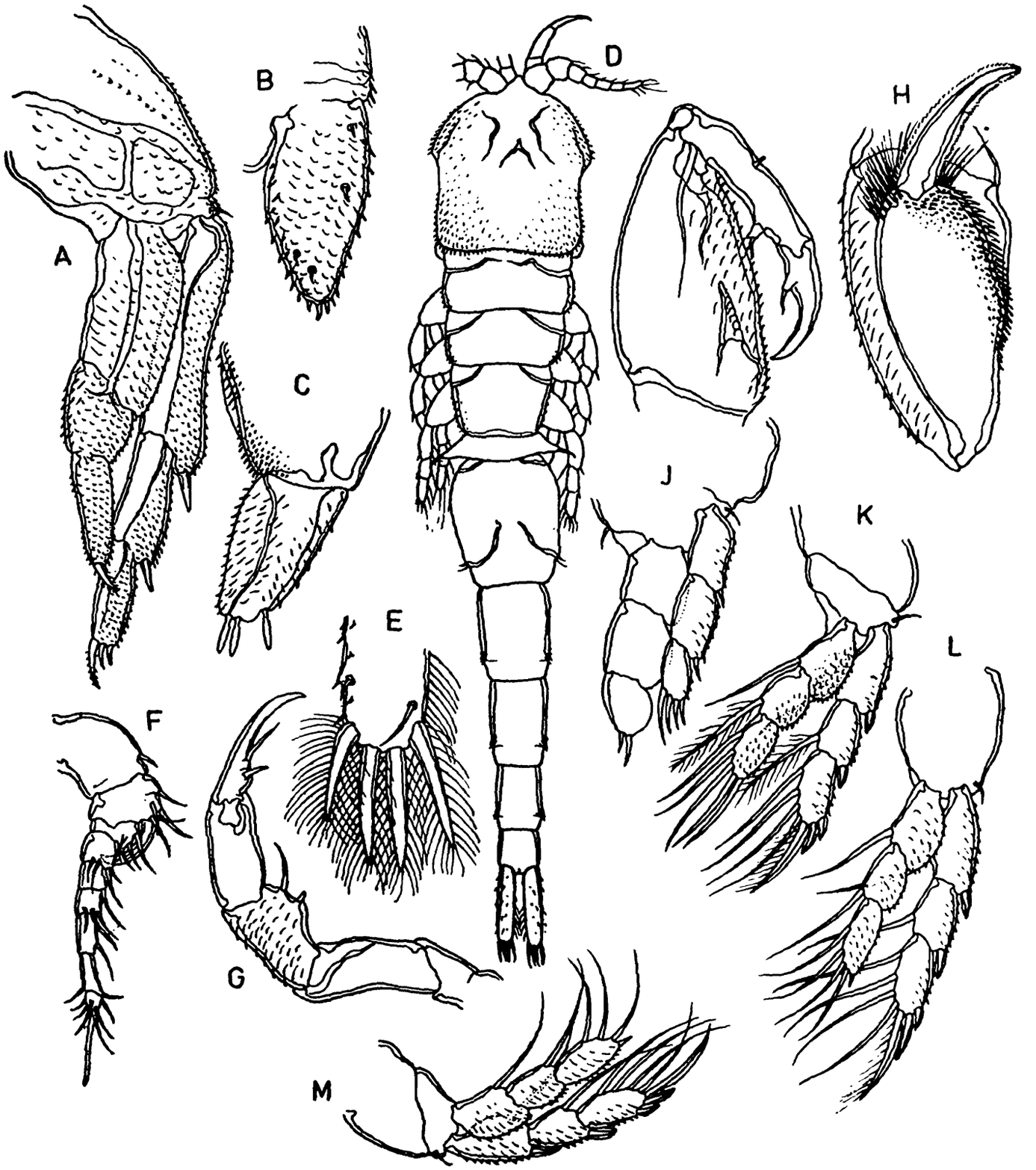


Fig. 226. *Eudactylina olivieri* (contd.) ; A-C, Female : A, leg 4; B, caudal ramus; C, leg 5. D-M, Male : D, male, dorsal view ; E, caudal ramus ; F, antennaule ; G, antenna ; H, maxilla ; I, maxilliped ; J-M, legs 1-4.

long, with rounded corners. Fifth segment anteriorly constricted. Genital segment longer than broad, abruptly narrowed beyond the middle. Abdomen two-jointed, as long as genital segment. Caudal rami long ovate, with two small apical spines. The body except the genital segment and abdomen smooth.

Second segment of antennule with a stout curved spine, third segment with a smaller spine. Antenna long and rather slender, second segment internally produced, carrying two setiform spines, surface scaly, third segment with scaly surface, fourth with two long setae. Mandible with five teeth. Inner lobe of maxillule much smaller than outer, both with two spines. Distal segment of maxilla with its inner half scaly, distal part strongly spiny and with a cluster of teeth. Claw with strongly spiny border. Basal segment of maxilliped with inner and distal borders spiny, thumb-like process large, distally flattened, distal segment proximally scaly, narrowing distalwards, apex trifid.

Distal segment of basipod of first leg scaly, rami greatly dissimilar and three-segmented, exopod much smaller than endopod, both rami fully scaly. Rami of second leg not modified, three-segmented and scaly, endopod longer than exopod and its first two segments highly flattened. Exopod of third leg long, endopod similar to that of second leg. Fourth leg similar to third but the exopod shorter than that of third leg, endopod narrower. Fifth leg narrowing, with three aesthete-like setae.

*Length.*—2.0 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 0+0, 2 | 0+I, 0+I, III |
| Leg 2 | 0+0, 0+0, 2 | 0+I, 0+I, III |
| Leg 3 | 0+0, 0+0, I | 0+I, 0+I, III |
| Leg 4 | 0+0, 0+0, I | 0+I, 0+I, III |

*Male.*—Cephalothorax almost similar to that of female. Thoracic segments two to four successively decreasing in width, fourth longer and narrowing backwards. Fifth segment short, laterally drawn out. Genital segment longer than broad, narrowing backwards. Abdomen long, slender and four-segmented, each with a

postero-lateral patch of spinules. Caudal rami elongate oblong, with four stout plumose spine-like setae. Unlike the female the dorsal side of the cephalothorax and abdomen sparsely spiny.

Antennule slender, nine-jointed, armed with setae except for the curved claw on second segment, last segment with an aesthete. Antenna similar to that of female but more slender. Maxilla stout, basal segment large and scaly, second segment broadening distalwards and conspicuously spiny, claw long, more than half the length of the distal segment and flanged. Basal segment of maxilliped elongate conical and sparsely scaly, with proximal inner process, distal segment with a small outer spine and a longer inner spine mounted on a base, a similar spine on the unguis.

Thoracic limbs one to four with slender, three-jointed, setose rami, their surface sparsely scaly. Rami of first leg modified, without setae.

*Length.*—1.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 0+0, II | 0+I, 0+I, IV |
| Leg 2 | 1+0, 1+0, 5+0 | 1+I, 1+I, 5+II |
| Leg 3 | 1+0, 1+0, 4+I | 1+I, 1+I, 5+II |
| Leg 4 | 1+0, 1+0, 3+I | 1+I, 1+I, 5+II |

*Host.—Mobula diabolus.*

*Distribution.*—Mediterranean, India (Cape Comorin).

*Remarks.*—In every character this species shows conspicuous difference from its congeners, the most noteworthy being the shape and comparative size of the rami of the legs. In all the other species of *Eudactylina* it is the exopod of the second leg that is modified and in the male the legs are all normal. But in *E. olivieri* it is the exopod of the third leg that is modified (elongated) and in the male the first leg is modified.

### **Eudactylina alata** Pillai
(Fig. 227)

*Eudactylina alata* Pillai, 1968b, p. 27, figs. 8-9.

*Female.*—Cephalothorax triangular, anterior border truncate, antero-lateral processes apically acute and directed backwards.

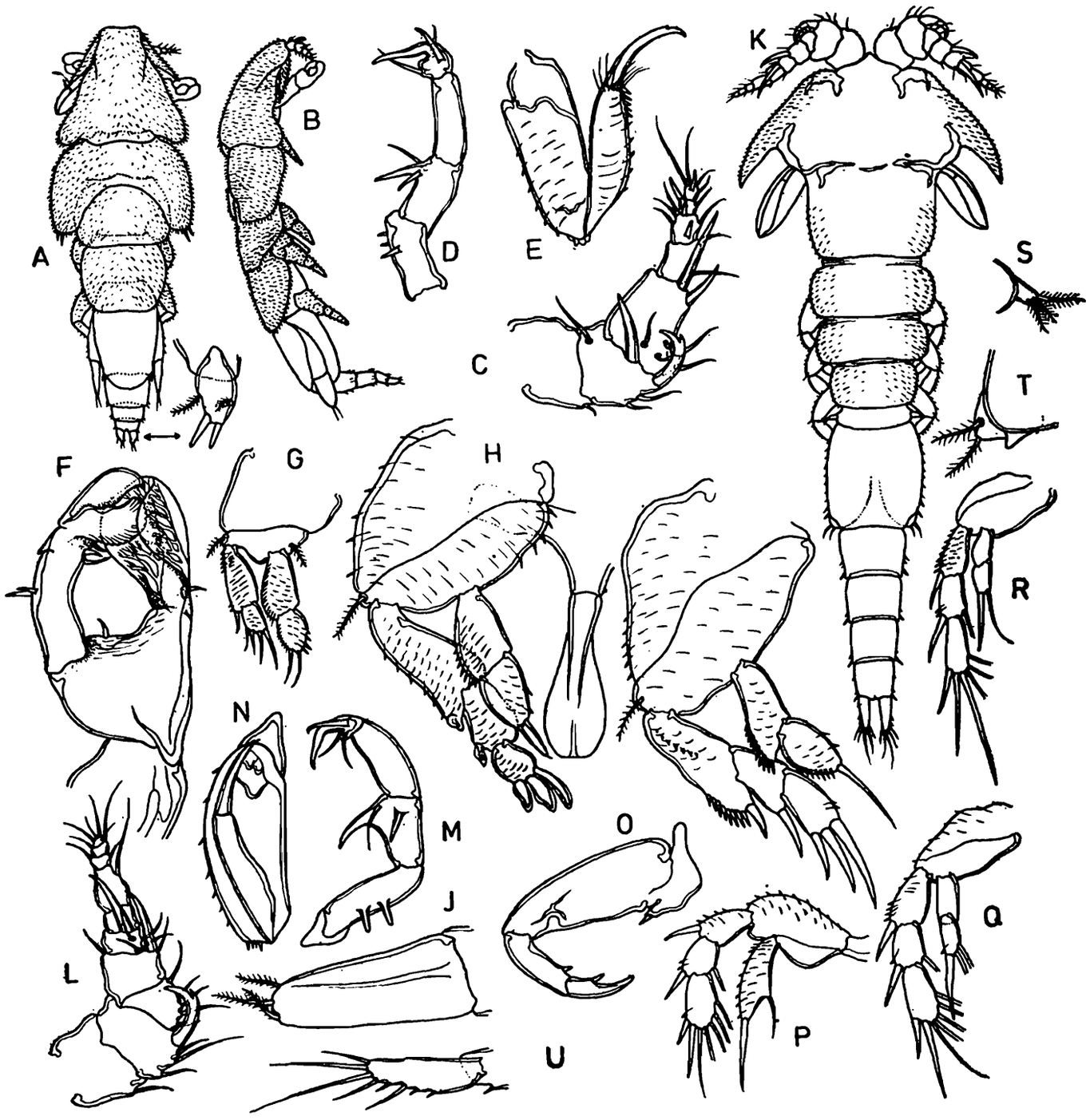


Fig. 227. *Eudactylina alata* Pillai : A-J, Female. A, female, dorsal view ; B, same, lateral view; C, antennule; D, antenna; E, maxilla; F, maxilliped; G, leg 1 ; H, leg 2 ; I, leg 3 ; J, leg 5. K-U, Male. K, male, dorsal view ; L, antennule ; M, antenna ; N, maxilla ; O, maxilliped ; P, leg 1 ; Q, leg 2 ; R, leg 4 ; S, leg 5 ; T, leg 6 ; U, caudal ramus.

Second thoracic segment broader than cephalothorax, posterolaterally produced on either side of the third segment into large wings overlapping the third segment, latter rounded. Fourth segment circular, overlapped by third and overlapping fifth, fifth

segment elongated and narrowing. Genital segment small. Abdomen very short, two-segmented. Caudal rami small, with two setae and two spines. Dorsal side of body up to fourth segment sclerotised and scaly, rest smooth, sclerotisation uniform.

Peduncle of antennule broad, three-segmented, second segment with curved bifid spine and a large spine, third segment with two large spines, flagellum slender and four-segmented. Basal segment of antenna with three inner spines, second segment with two spines and a seta, fourth basally swollen, with a long spine and two setae, one of them very long, distal part long and slender. Basal segment of maxilla not enlarged, sparsely scaly, distal with a row of inner distal teeth and a small bunch of hairs, claw long and slender, with two outer subapical denticles. Basal segment of maxilliped rather small, inner distal process large, flattened and folded, distal segment with five spines, apex bifid and flattened.

First leg very small, basipod unarmed, rami two-jointed and sparsely scaly, endopod slightly broader. Basipod of second leg sparsely scaly, exopod long and three-segmented, with blunt flanged spines, endopod two-jointed and comparatively very small. Exopod of third leg much longer than endopod, basal segment with a row of outer spines, all segments with long claws, endopod small, both segments with a row of spines, distal segment with a long spine. Fourth leg like third. Fifth leg a large lobe carrying three setae.

*Length.*—1.0 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 2 | 0+I, IV |
| Leg 2 | 0+0, 2 | 0+I, 0+I, III |
| Leg 3 | 0+0, I | 0+I, 0+I, III |
| Leg 4 | 0+0, I | 0+I, 0+I, III |

*Male.*—Cephalothorax large, antero-laterally prolonged into a pair of large backwardly directed processes, posterior half abruptly narrowed. Thoracic segments two to four successively narrowing, fifth segment very small. Genital segment slightly broader than fifth segment. Abdomen long, four-segmented and narrowing. Caudal rami with five setae and three short spines.

Antennule as in female, fourth and fifth segments with one long spine. Basal segment of antenna with two spines, second segment with two spines and one seta. Maxilla with stout basal segment, distal segment slender, unguis long. Basal segment of maxilliped with proximal inner lobe carrying a spine, distal segment with two spines, one on the unguis.

Endopod of first leg one-jointed, exopod three-jointed, endopod of second and third legs two-jointed, exopods three-jointed, fourth leg similar to third. Fifth and sixth legs present.

*Length.*—0.9 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+I | 0+I, 1+I, 5+II |
| Leg 2 | 0+0, 2+I | 0+I, 1+I, 5+II |
| Leg 3 | 0+0, 1+I | 0+I, 1+I, 3+III |
| Leg 4 | 0+0, 1+I | 0+I, 1+I, 3+III |

*Host.*—*Rhynchobatus* sp.

*Distribution.*—India (Kerala).

*Type* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2160/2.

*Remarks.*—Both sexes of this species possess very diagnostic characters. The lobes of the second segment of the female and the cephalothorax of the male, the bifid spine on the antennule, the armature of the legs of the female and the segmentation of the endopods of the legs of the male are worth mentioning.

## **Eudactylina lancifera** Pillai
(Fig. 228)

*Eudactylina lancifera* Pillai, 1968b, p. 24, figs. 7-8.

*Female.*—Cephalothorax oblong, with antero-median rostral projection and antero-lateral apically acute processes. Thoracic segments two to five increasing in length, each with sclerotised

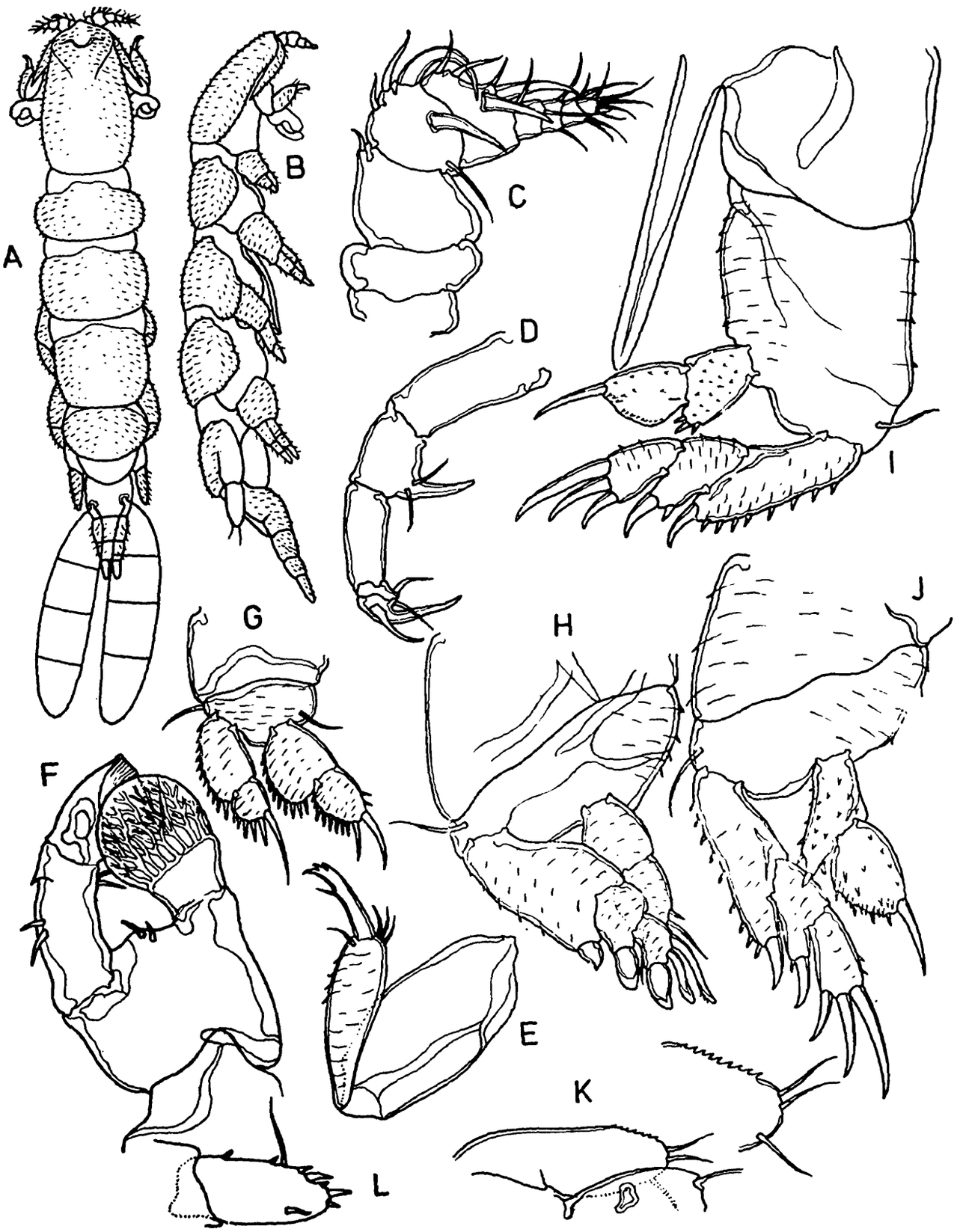


Fig. 228. *Eudactylina lancifera* Pillai : A, female, dorsal view ; B, same, lateral view ; C, antennule ; D, antenna ; E, maxilla ; F, maxilliped ; G-K, legs 1-5 ; L, caudal ramus.

dorsum. Fifth segment narrowing, with transversely ovate sclerotisation. Genital segment narrow, as long as broad. Abdomen very small, two-jointed. Caudal rami with two setae and seven spines of different size.

Fourth segment of antennule with a straight and a curved long spine, fifth segment with two straight long spines. Second segment of antenna with inner stout spine and two setae, base of fourth segment with one spine and two setae, claw long. Inner lobe of maxillule with one and outer with two subsimilar spines. Basal segment of maxilla very broad, distal scaly and with a few inner spines and three distal outer setae, claw slender, with two outer distal teeth. Basal segment of maxilliped of moderate size, produced into a stout apically flattened process, distal segment stout, with four spines, apex ventrally flattened.

First leg with two-jointed rami, with strongly spiny outer border. Exopod of second leg modified, longer than endopod, outer spines stout and blunt, third segment with two additional slender spines. Basipod of third leg much elongated, inter-coxal plate with lance-like process, endopod two-jointed and exopod three-jointed. Fourth leg with normal basipod, rami similar to those of third leg. All the legs sparsely scaly. Fifth leg with three apical setae.

*Length.*—1.6 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, II | 0+0, I |
| Leg 2 | 0+0, III | 0+I, 0+I, III |
| Leg 3 | 0+0, I | 0+I, 0+I, III |
| Leg 4 | 0+0, I | 0+I, 0+I, III |

*Host.—Pristis* sp., *Rhynchobatus* sp.

*Distribution.*—India (Kerala).

*Type* in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2161/2.

*Remarks.*—*E. puriensis* Tripathi (1962a) collected from *Rhynchobatus djeddensis* at Puri shows some resemblance to *E. lancifera.* Since Tripathi has failed to mention many characters which are of specific importance I am unable to decide whether *E. lancifera* is a synonym of *E. puriensis* or not. Pending a decision I am omitting Tripathi's species from the present work.

## Genus **Nemesis** Risso

*Nemesis*, Wilson, 1922, p. 32 ; Yamaguti, 1963, p. 166.

*Diagnosis.*—Cephalothorax rounded, narrower than second thoracic segment. Thoracic segments two to four free, laterally folded downwards. Fifth segment generally much narrower than fourth, with postero-lateral lobes carrying the vestigial legs. Genital segment small. Abdomen short and narrow, two or three-segmented. Caudal rami with apical spines.

Antennule slender, with stiff setae. Antenna four-jointed, distal segment claw-like. Maxillule two lobed, with long spines. Maxilla two-jointed, distal segment with spiny claw, a toothed bulge and a patch of hairs. Maxilliped large, prehensile, distal segment a stout claw. First leg highly modified, endopod two-jointed, exopod one-jointed. Legs two to four with two-jointed short rami armed with stout spines. Fifth leg a small lobe.

Male with narrow thoracic segments, genital segment large, abdomen two to three-segmented. Cephalic appendages as in female. Legs two to four with setose, two-jointed rami, one or two setae on distal endopod segment of third and fourth legs modified into naked chitinised structures. Sixth leg a plumose seta.

Type species.—*N. lamna* Risso.

*Discussion.*—Yamaguti listed under this genus eleven species. Since then Cressey (1967b) added *N. aggregatus.* Only four species are known from Indian waters. Species of *Nemesis* except *N. lamna* are very much similar and specific identification is largely based on minor differences.

*Key to species of* **Nemesis**

| | | |
|---|---|---|
| 1. | Fifth thoracic segment as broad as fourth | *.lamna* Risso |
| — | Fifth thoracic segment narrower than fourth | .2 |
| 2. | Second segment of antenna with a large patch of spines | *robusta* (van Beneden) |
| — | Second segment of antenna with a small patch of spines | .. 3 |
| 3. | Second segment of antenna with an inner tubercle | *versicolor* Wilson |
| — | Second segment of antenna without inner tubercle | *.aggregatus* Cressey |

## **Nemesis aggregatus** Cressey
## (Figs. 229, 230 A-H)

*Nemesis aggregatus* Cressey, 1967b, p. 6, figs. 1, 2, 6-20.

*Female.*—Cephalothorax nearly circular, with slightly irregular outline. Second thoracic segment only moderately broader than cephalothorax and subequal to third in length and width, fourth longer but narrower than third, fifth much narrower, nearly as long as broad, distally convex and overlapping genital segment. Genital segment short, narrower than fifth segment. Abdomen short, three-segmented, anal segment longest. Caudal rami oblong, with three setae and three spines, outer distal part produced.

Antennule twelve-segmented. Second segment of antenna stouter than third, with a patch of fifteen to eighteen blunt spines, distal segment basally enlarged, with two setae. Mandible with eight blunt teeth. Inner ramus of maxillule with two short and one long spine, outer with two long spines. Distal segment of maxilla with rounded spiny distal lobe, inner distal part spiny, unguis bilaterally toothed. Basal segment of maxilliped with proximal inner process, distal segment with proximal seta and distal spine.

Exopod of first leg with pronounced incision on outer border, the row of teeth followed by a pectinate process, distal lower lobe with three spines, apical bulge covered with teeth, endopod segments strongly spiny, distal segment with two long apical spines. Distal segment of exopod of second leg with seven spines, that of endopod with six longer spines. Distal exopod segment of third

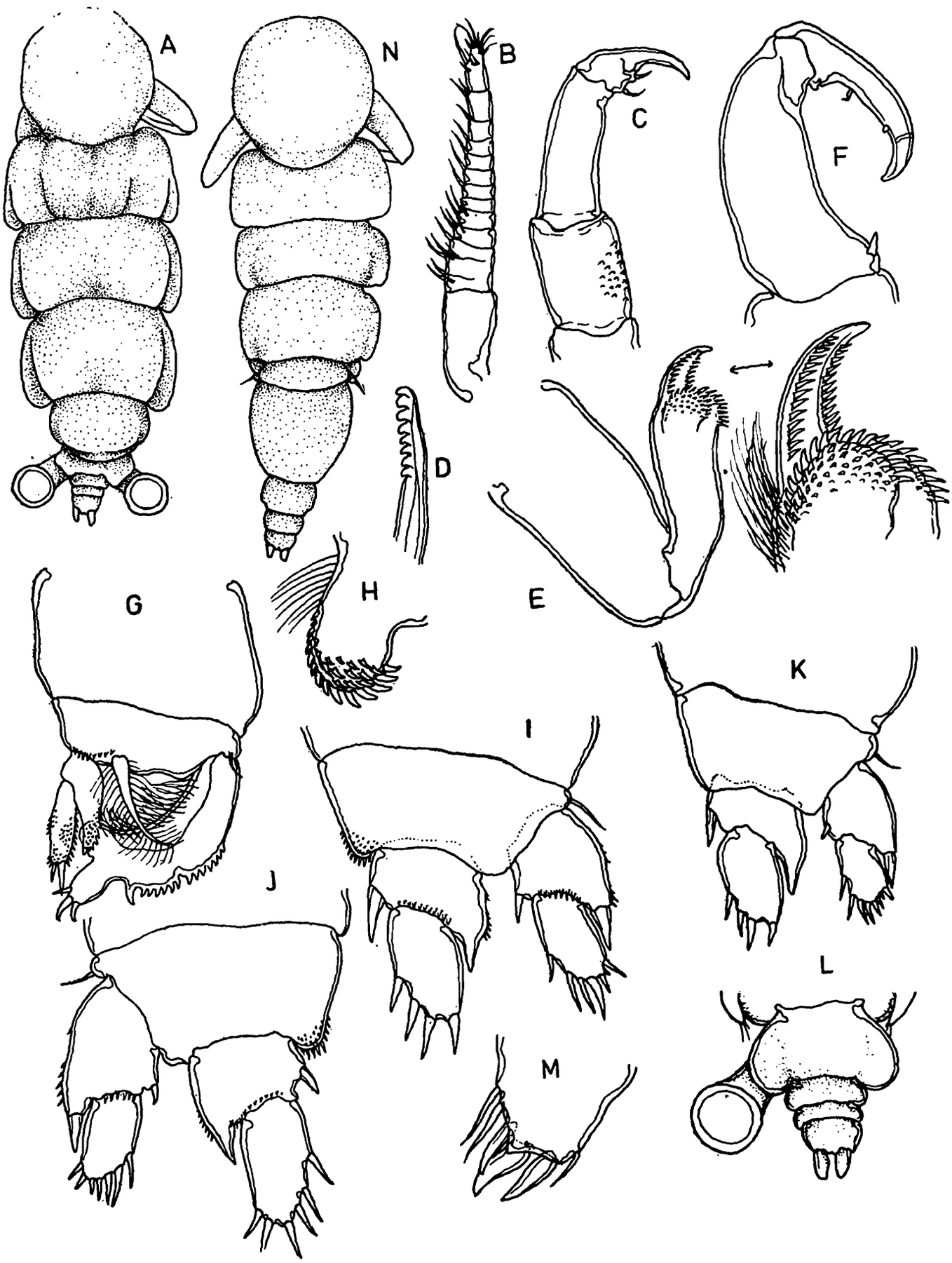


Fig. 229. *Nemesis aggregatus* Cressey : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible ; E, maxilla ; R, maxilliped ; G, leg 1 ; H, same, tip of exopod ; I, leg 3 ; J, leg 2 ; K, leg 4 ; L, posterior part of trunk ; M, caudal ramus ; N, male, dorsal view.

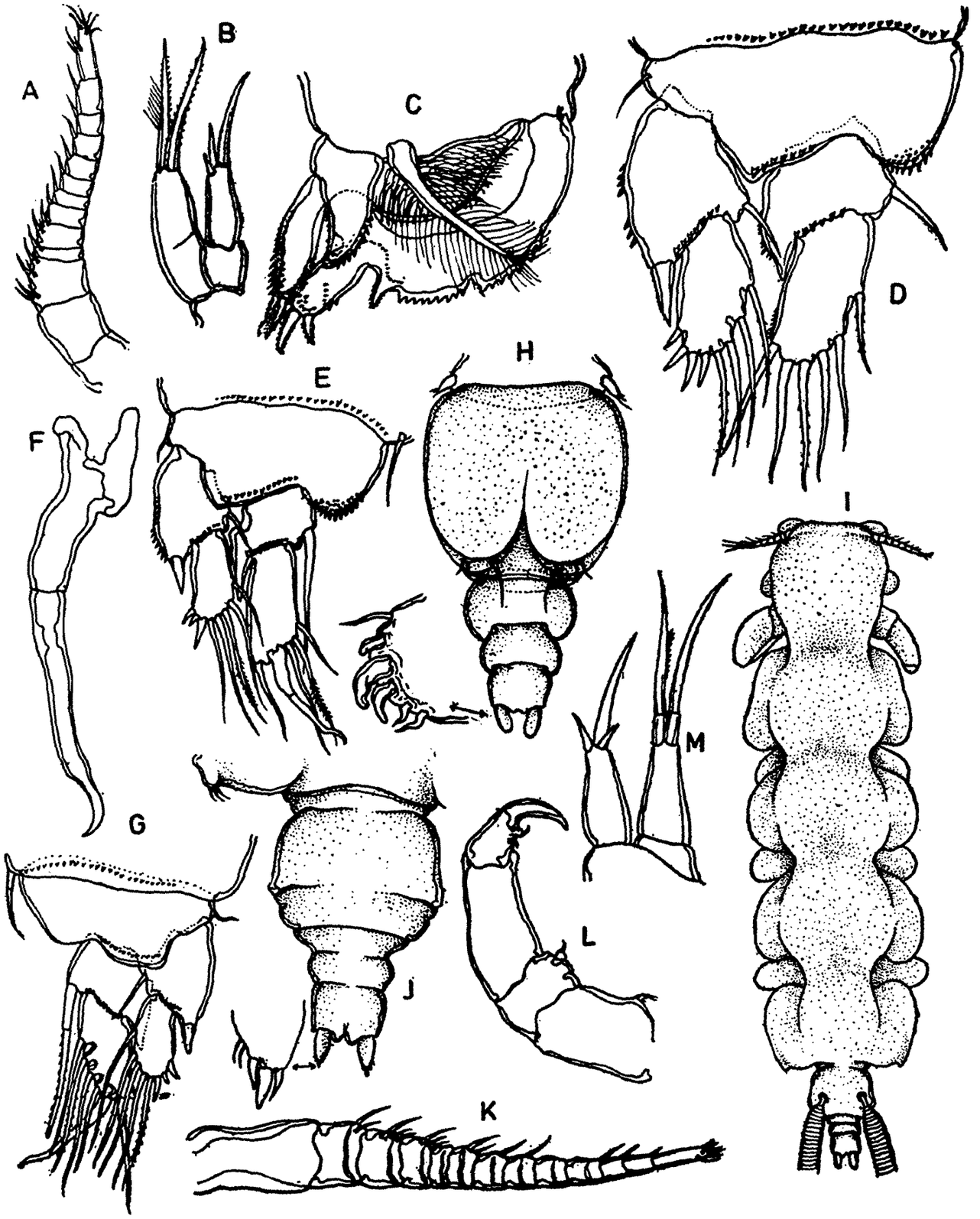


Fig. 230. *Nemesis aggregatus* (contd.) : Male : A, antennule ; B, maxillule ; C, leg 1 ; D, leg 2 ; E, leg 3 ; F, same, modified seta on endopod ; G, leg 4 ; H, posterior part of trunk. I-M, *Nemesis lamna* Risso : I, female, dorsal view ; J, posterior part of trunk ; K, antennule ; L, antenna : M, maxillule.

leg with seven spines, that of endopod with four spines, the corresponding segments of the fourth leg with eight and four spines respectively. Fifth leg a small lobe carrying three setae.

*Length.*—4.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, II | 0+I, III |
| Leg 2 | I+0, VI | 1+I, VII |
| Leg 3 | I+0, IV | I+I, VII |
| Leg 4 | I+0, IV | I+1, VIII |

*Male.*—Cephalothorax comparatively larger than in female, second thoracic segment slightly broader than cephalothorax, longer than third, fourth segment slightly narrower but clearly longer than third. Fifth segment very short, much narrower than fourth, with prominent lateral projections carrying the fifth legs. Genital segment large, narrowing backwards. Abdomen longer and stouter than in female, three-segmented, first segment large. Caudal rami with curved spines.

Cephalic appendages as in female. First leg as in female. First segment of exopod of second leg with one seta and one spine, second with four setae and four spines, first segment of endopod with one seta, second with six setae. Distal exopod segment of third leg with five setae and three spines, that of endopod with five setae, fourth seta from the inside converted into a highly chitinised sickle-shaped jointed process, seta on first endopod segment long. Second exopod segment of fourth leg with five setae and three spines, that of endopod with six setae, fifth seta modified but less than that of third leg. Fifth leg a small lobe with three small setae, sixth composed of two stout setae and a long seta separated by a wide gap.

*Length.*—4.0 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, II | 0+I, III |
| Leg 2 | 1+0, 6 | 1+I, 4+IV |
| Leg 3 | 1+0, 5 | 1+I, 5+III |
| Leg 4 | 1+0, 6 | 1+I, 5+III |

*Host.—Alopias vulpinus.*

*Distribution.*—Indian ocean.

*Types* in the U.S. National Museum.

*Remarks.*—Compared to the description of this species by Cressey the thoracic segments of my specimen appear narrower. But this can be the result of contraction. The second segment of the antenna has more than twelve spines. The spiny lobe of the maxilla is less produced than shown by Cressey. There is also slight difference in the armature of the legs. The inner lobe of the maxillule has three and not two spines and one of the spines on the outer lobe has a row of spinules.

## **Nemesis lamna** Risso
(Figs. 230 I-M, 231 A-G)

*Nemesis lamna* Risso, 1826, p. 136, pl. 5, fig. 25 ; Wilson, 1932, p. 461, pl. 32 ; Heegaard, 1962, p. 184, fig. 201; Cressey, 1968, p. 11, figs. 43-58 ; Hewitt 1969b, p. 1, figs. 1-50.
*Nemesis carchariarum* Roux, 1828, p. 176, pl. 20, figs. 10-11.
*Nemesis mediterranea* Heller, 1868, p. 220, pl. 21, fig. 2.

*Female.*—Cephalothorax longer than broad, narrowing backwards, producing a distinct neck. Thoracic segments two to four separated by deep lateral constrictions, lateral borders of segments convex, segmentation dorsally indistinct, segments subequal in size. Fifth segment anteriorly as broad as fourth, narrowing backwards, postero-laterally forming distinct lobes carrying the fifth legs. Genital segment small, about half the width of the fifth segment. Abdomen two to three segmented. Caudal rami small, elliptic, with three distal spines and two outer setae.

Antennule stout, thirteen-jointed and sparsely setose. Second segment of antenna short, its inner border with a tubercle carrying a short spine, distal segment with a spine and a cylindrical process carrying a spinule, claw fairly stout. Outer lobe of maxillule with one long and two short spines, inner with two long subequal spines, inner of the two with strong barbs. Mandible with nine blunt teeth. Maxilla stout, distal segment with large, projecting spiny lobe,

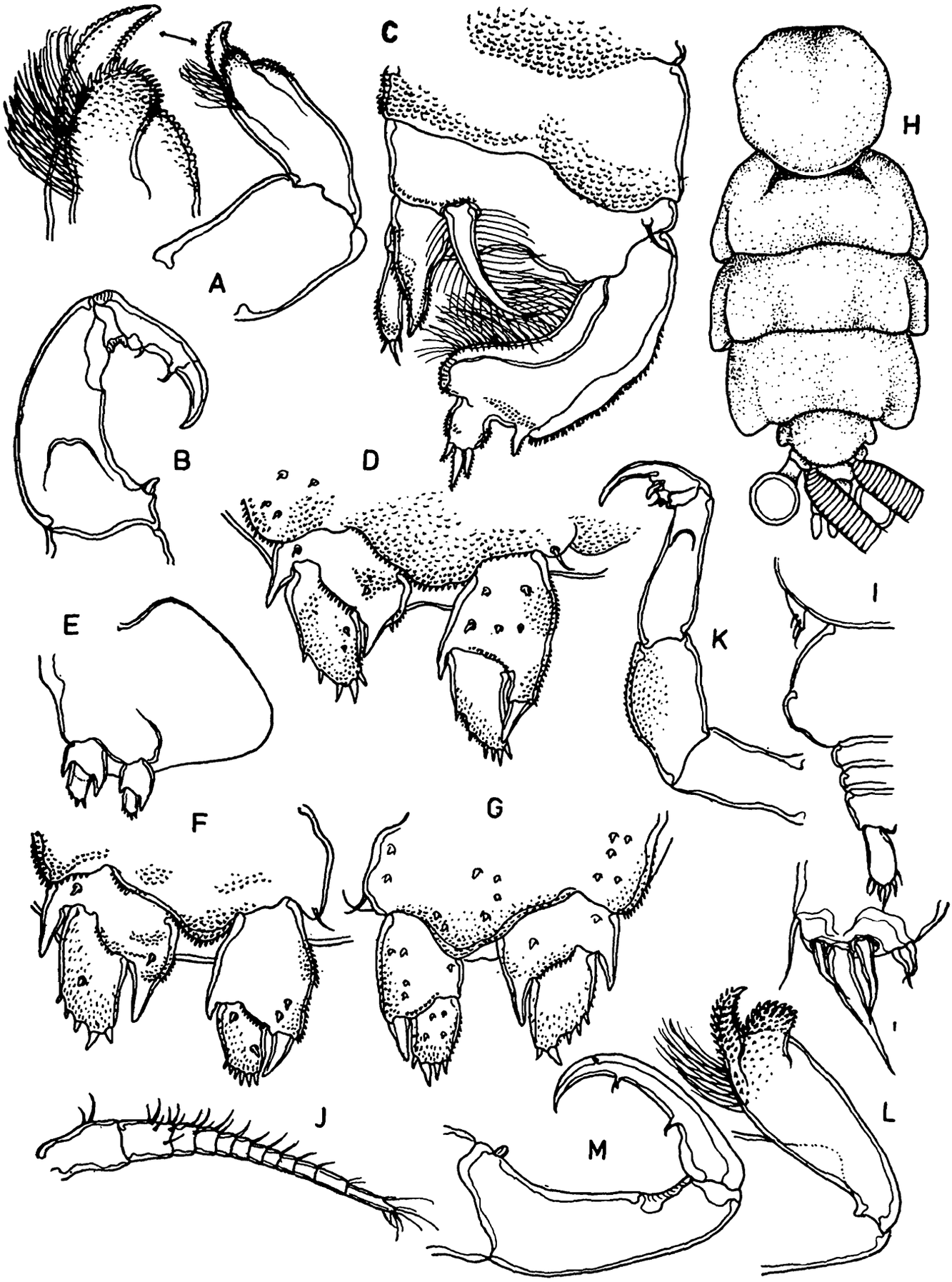


Fig. 231. *Nemesis lamna* (contd.) : A, maxilla ; B, maxilliped ; C, leg 1 ; D, leg 2 ; E, leg 3 ; F, same, rami enlarged ; G, leg 4 ; H-M, *Nemesis robusta* (van Beneden) : H, female, dorsal view ; I, posterior part of trunk; J, antennule ; K, antenna ; L, maxilla ; M, maxilliped.

unguis with blunt teeth. Distal segment of maxilliped with two setiform spines, basal segment with proximal inner spine.

Outer border of exopod of first leg with comparatively small teeth, inner process short, with very small tubercles, distal lobe small, with three spines. Distal segment of endopod with three spines. Distal segment of both rami of legs two to four short. Second endopod segment of second leg with five short spines, that of exopod with six spines. The corresponding segments of third leg with five and six spines and of fourth with five and four spines respectively. Fifth leg a small lobe carrying three setae.

*Length.*—7.0 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, III | 0+I, III |
| Leg 2 | 0+0, V | 0+I, VI |
| Leg 3 | 0+0, V | 0+I, VI |
| Leg 4 | 0+0, V | 0+I, IV |

*Host.—Cetorhinus maximus, Isurus oxyrhynchus, Carcharodon carcharias, Lamna nasus, Alopias vulpinus, Odontaspis ferox, Lichia amia.*

*Distribution.*—Cosmopolitan.

*Remarks.*—In practically every character this species is different from its congeners. The shape of the body, especially that of the fifth segment and the shape and armature of the rami of legs two to four easily distinguish it.

**Nemesis robusta** (van Beneden)
(Figs. 231 H-M, 232, 233 A-D)

*Ergasilina robusta* van Beneden, 1851, p. 97, pl. 3, figs. 1-2.
*Nemesis robusta ;* Heller, 1868, p. 221 ; Hewitt, 1969b, p. 14, figs. 51-57 ; Cressey, 1967b, p. 6.
*Nemesis pallida* Wilson, 1932, p. 464, pl. 33, figs. b-p.

*Female.*—Cephalothorax irregularly circular, overlapping the second thoracic segment, latter regularly broadening backwards

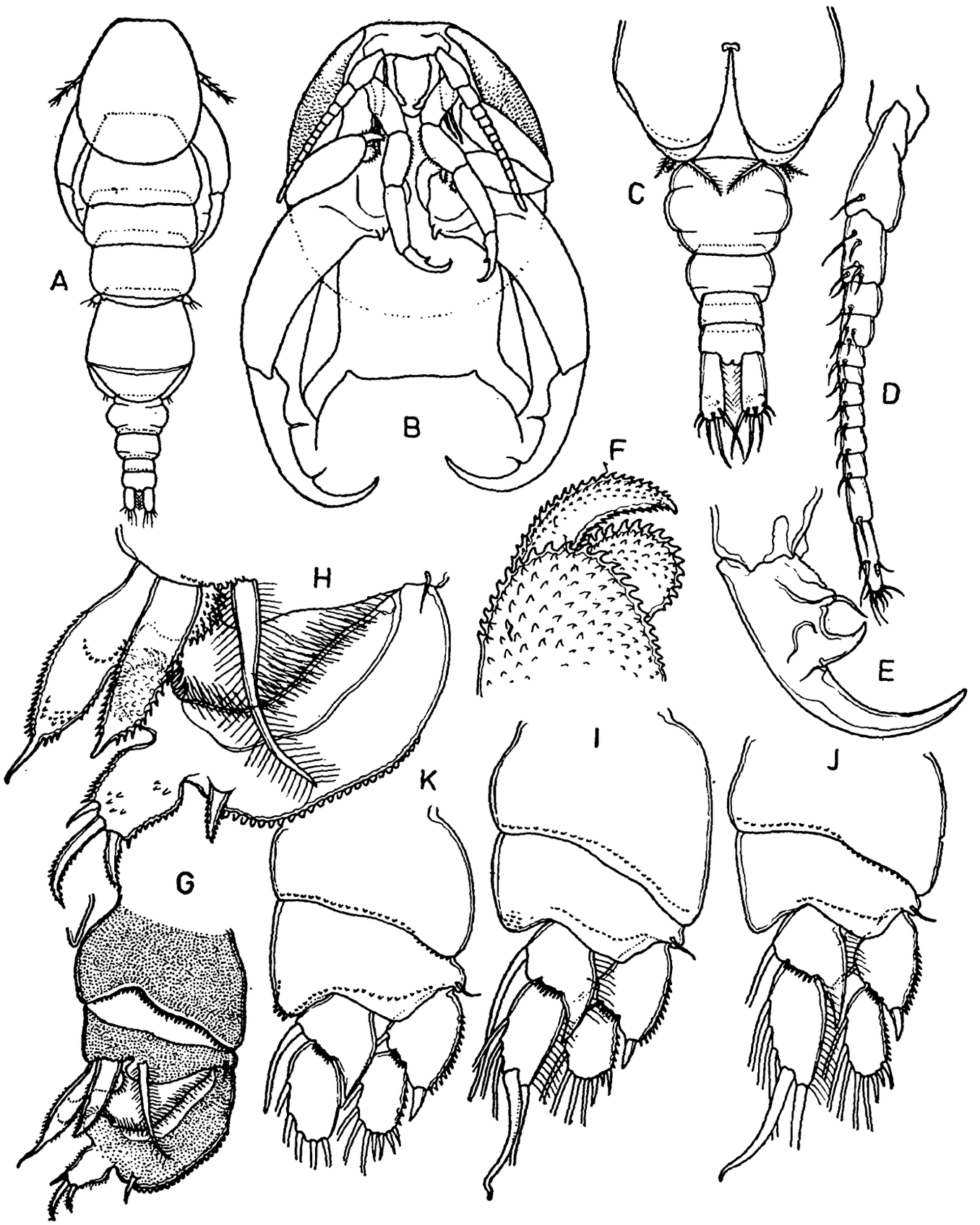


Fig. 232. *Nemesis robusta* (contd.) : A, male, dorsal view ; B, anterior part, ventral view ; C, posterior part, ventral view ; D, antennule ; E, tip of antenna ; F, maxilla ; G, leg 1 ; H, same, rami enlarged ; I-K, leg 2-4.

and much broader than cephalothorax. Third segment similar to second, but slightly broader, fourth longer but narrower than third. Fifth segment about half as broad as fourth, with prominent ear-like lateral lobes carrying the legs. Genital segment much broader than long. Abdomen three-jointed, third segment longest. Caudal rami oblong, with three slender and three stout spines distally drawn out.

Antennule slender and twelve-segmented. Second segment of antenna with a large patch of small denticles, fourth segment with two short spines and a short seta, claw well curved. Distal segment of maxilla longer than basal, the spiny lobe curved and projecting, unguis fully covered with teeth. Process on basal segment of maxilliped blunt, distal segment with proximal seta and distal spine carrying a setule.

Endopod segments of first leg strongly spiny, lower border of basal segment of exopod with sharp spines. Distal segment of endopod of leg two with six comparatively short spines, that of exopod with eight spines, corresponding segments of third leg with four and seven spines respectively and of fourth leg with four and eight. Rami of legs two to four short but broad.

*Length.*—3.3 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, I | 0+I, III |
| Leg 2 | I+0, VI | I+I, VIII |
| Leg 3 | I+0, IV | I+I, VII |
| Leg 4 | I+0, IV | I+I, VIII |

*Male.*—Cephalothorax anteriorly truncated, broadening backwards and posteriorly rounded, considerably overlapping second thoracic segment. Thoracic segments two to four successively decreasing in width, fifth very short. Genital segment much enlarged, as broad as fourth segment. Abdomen four-segmented, first two segments large, others small. Caudal rami broadening, with normal plumose setae.

Antennule slender, fifteen-jointed. Antenna elongated, distal segment with basal expansion carrying a seta and followed by a curved claw. Distal part of distal segment of maxillule strongly spiny. Maxilliped similar to that of female but more slender.

Basal outer part of endopod of first leg with large spiny bulge, both segments apically produced, exopod with blunt lower spines. Legs two to four showing the usual dimorphism.

Length.—2.9 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, 0+0 | 0+I, III |
| Leg 2 | 1+0, 5 | 1+I, 4+III |
| Leg 3 | 1+0, 5 | 1+I, 5+III |
| Leg 4 | 1+0, 5 | 1+I, 4+IV |

*Host.*—A wide variety of elasmobranchs.

*Distribution.*—Cosmopolitan.

*Remarks.*—This widely distributed species was recently described by Hewitt. He made *N. aggregatus* Cressey a synonym of *N. robusta* alleging that the most important character namely the number of spines on the second segment of the antenna is variable. This is indeed so. However if the difference in number is significant which is true in the present case it can have specific value.

It may be that the width of the thoracic segments depends on the degree of the folding of the segments downwards. But *N. robusta* is really robust while *N. aggregatus* has a more slender body. The body of the males of these two species shows easily recognisable differences. *N. aggregatus* has a stouter antennule, a stouter antenna, a sharp process on the basal segment of the maxilliped (blunt in *N. robusta*), and blunt spines on the caudal rami (drawn out in *N. robusta*). They also differ in the armature of the legs. In the male of *N. aggregatus* the cephalothorax is narrow behind but broad in *N. robusta*. The abdomen is three-segmented in *N. aggregatus* but four-segmented in *N. robusta*. The caudal rami have totally different armature.

## **Nemesis versicolor** Wilson
(Fig. 233 E-O)

*Nemesis versicolor* Wilson, 1913, p. 236, pl. 38, figs. 190-194, pl. 40 ; Yamaguti 1963, p. 168, pl. 195, fig. 1 ; Cressey, 1967b, p. 6.

*Female.*—Cephalothorax subcircular, slightly broader than long, not overlapping second thoracic segment. Latter much broader than cephalothorax, antero-laterally rounded and shoulder-like, postero-laterally slightly produced into a lobe overlapping third segment. Third segment similar to second but shorter, fourth narrower than third, both postero-laterally angular. Fifth segment about half the width of fourth, with small lobes carrying the fifth legs. Genital segment broader than fifth. Abdomen small, three-segmented. Caudal rami ovate, with three setae and three spines, drawn out and setiform.

Antennule stout, eleven-segmented. Second segment of antenna with a few outer spines, inner border with small lobe carrying two spines. Fourth segment carrying two short setae and a small spine. Maxilla small, distal segment broadening distalwards, with projecting spiny lobe and outer bunch of hairs, claw with serrate border. Maxilliped with inner proximal spine, distal segment strongly curved, with two setae.

Basal exopod segment of first leg without median incision, teeth sharp, spines stout, distal endopod segment with one spine. Rami of legs two to four short but stout, distal endopod segment of second leg with six similar spines, distal exopod segment small, with eight spines. Distal endopod segments of third and fourth legs with four spines, that of exopod with eight and seven spines respectively. Fifth leg with three setae.

*Length.*—3.2 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 0+0, I | 0+I, III |
| Leg 2 | I+0, VI | I+I, VIII |
| Leg 3 | I+0, IV | I+I, VIII |
| Leg 4 | I+0, IV | I+I, VII |

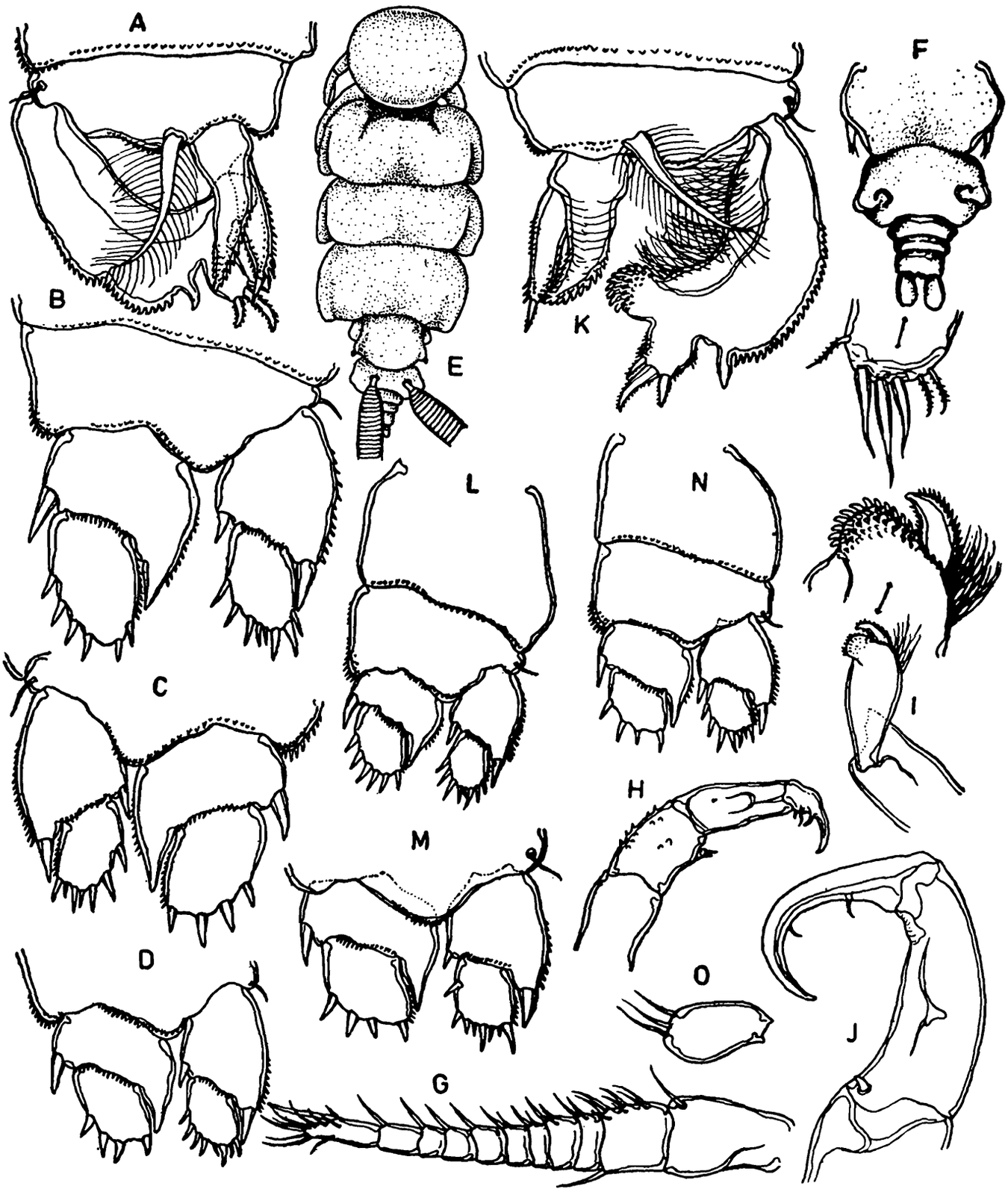


Fig. 233. *Nemesis robusta* (contd.) ; A-D, legs 1-4, female. E-O, *Nemesis versicolor* Wilson : E, female, dorsal view ; F, posterior part of body ; G, antennule ; H, antenna ; I, maxilla ; J, maxilliped ; K-O, legs 1-5.

*Host.—Sphyrna zygaena, Carcharinus maculipinnis.*

*Distribution.*—West Indies, Madagascar.

*Remarks.*—This species is said to possess a pair of knobs on the lateral borders of the cephalothorax and Wilson has illustrated them. But in fully relaxed specimens no knobs are visible.

*N. robusta, N. versicolor* and *N. aggregatus* show very close similarity and contraction due to preservation may alter the shape. However *N. robusta* has a really robust body, *N. aggregatus* a slender one and *N. versicolor* comes between the two. As the rami of the legs are not affected by contraction they must be used for specific identification. They do show difference.

## Genus **Kroyeria** van Beneden

*Kroyeria* van Beneden, 1853, p. 23 ; Wilson, 1932, p. 452 ; Yamaguti, 1963, p. 161.

*Diagnosis.*—Cephalothorax large, postero-laterally produced into triangular lobes, postero-medially transverse and with a pair of styliform processes. Dorsal side with prominent Y-shaped rib. Thoracic segments two to four subsimilar, very slightly narrowing, fifth and genital segments fused into a long cylindrical or slightly dorso-ventrally flattened trunk. Abdomen short, indistinctly three-segmented. Caudal rami slender, with apical setae and spines. Egg tubes short, with large eggs.

Antennule slender. Antenna chelate. Maxillule bipartite, with long setae. Maxilla two-jointed, claw with a basal partition. Maxilliped large, prehensile. Legs one to four with three-jointed setose rami, endopod externally spiny, intercoxal plate of legs two to four with a pair of dagger-shaped processes.

Male with shorter cephalic processes, shorter trunk and longer abdomen and caudal rami.

Type species.—*K. lineata* van Beneden.

*Discussion.*—Kabata and Gussev (1966) prepared a key based on the armature of the legs. If possible this will be very useful but in many species there are not sufficient differences in the armature of the legs and at least in a few species the armature is not correctly described. In *K. gracilis*, *K. dispar* and *K. gemursa* the legs show recognisable difference. In others other characters will have to be used. As in the key presented below the presence of an accessory lobe on the cephalic processes and its position, the shape of the tip of the process and the length of the process in relation to the free thoracic segments provide useful diagnostic characters.

*Key to species of* **Kroyeria**

| | | |
|---|---|---|
| 1. | Cephalic processes with accessory lobe | .2 |
| — | Cephalic processes without accessory lobe | .5 |
| 2. | Accessory lobe placed close to the tip making it appear bifid | .3 |
| — | Accessory lobe placed away from the tip | .*longicauda* Cressey |
| 3. | Cephalic processes reaching hind border of fourth thoracic segment | .4 |
| — | Cephalic processes not reaching hind border of fourth thoracic segment | *gracilis* Wilson |
| 4. | Anal segment of abdomen with distal chitinous swelling | *gemursa* Cressey |
| — | Anal segment of abdomen without chitinous swelling | .*minuta* Pilla |
| 5. | Cephalic processes apically flattened | *spatulata* Pearsei |
| — | Cephalic processes apically not flattened | .6 |
| 6. | Cephalic processes reaching hind border of fourth thoracic segment | .*sphyrnae* Rangnekar |
| — | Cephalic processes not reaching hind border of fourth segment | 7 |
| 7. | Endopod of legs one to four spiny | .*echinata* Rangnekar |
| — | Endopod of legs one to four not spiny | *dispar* Wilson |

## **Kroyeria dispar** Wilson
(Figs. 234, 236 A-D)

*Kroyeria dispar* Wilson, 1935, p.7 ; Yamaguti, 1983, P.162 ; Cressey, 1967b, p.14 ; 1970, p.18, fig. 61.

*Female.*—Cephalothorax much broader than long, postero-lateral lobes small and apically rounded, median lobe slightly convex. Cephalic processes short, overreaching the second thoracic

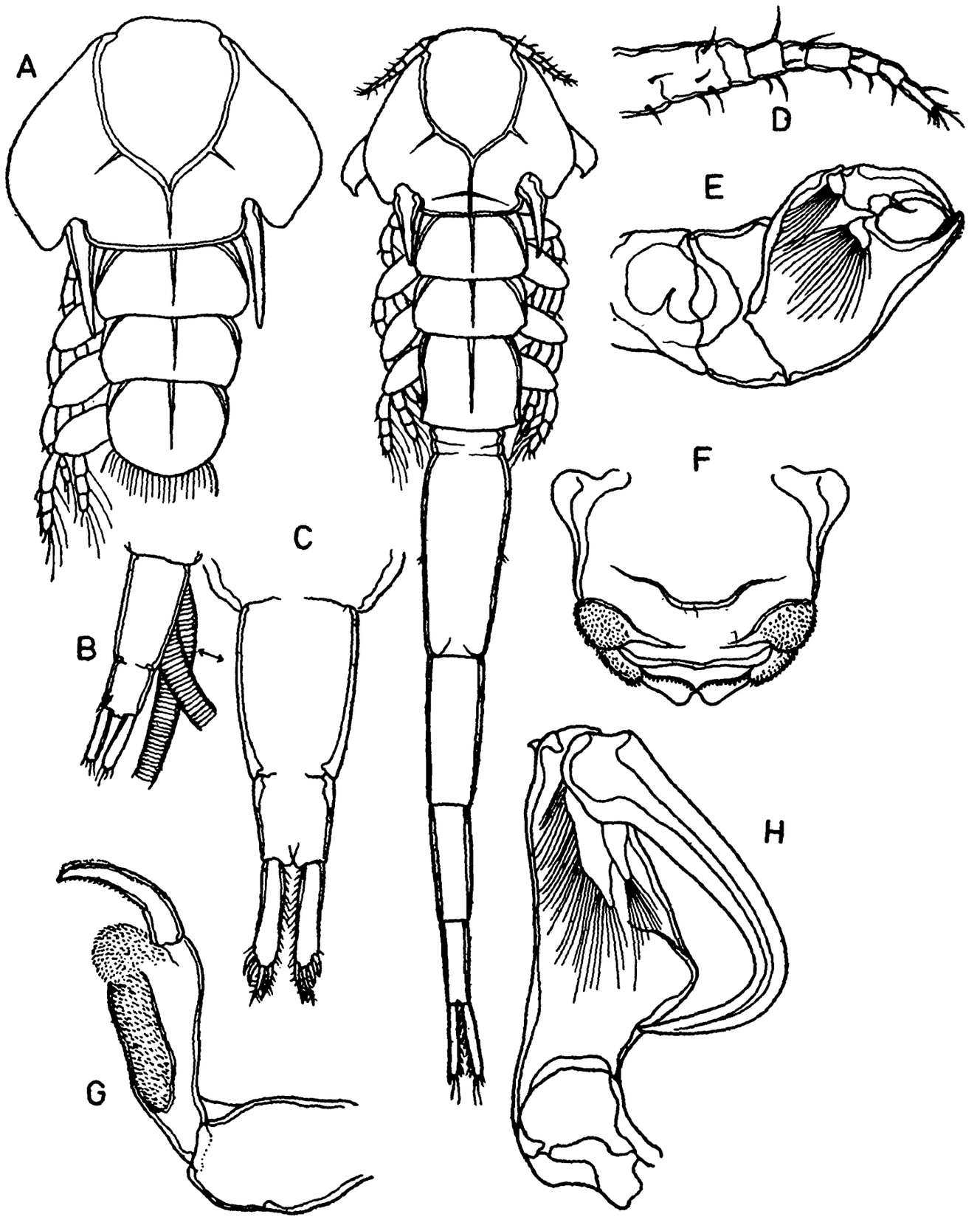


Fig. 234. *Kroyeria dispar* Wilson : A-H, Female. A, female, anterior end ; B, same, posterior end ; C, abdomen ; D, antennule ; E, antenna ; F, labrum ; G, maxilla ; H, maxilliped, I, Male, dorsal view.

segment. Thoracic segments successively increasing in length and decreasing in width, fourth segment posteriorly rounded and overlapping genital segment. Genital segment long and cylindrical, more than twice as long as the rest of the body. Abdomen short, apparently two-segmented, first segment twice as long as second. Caudal rami slightly longer than distal segment of abdomen, with two plumose setae, two setiform spines and one small seta.

Antennule eight-segmented and sparsely setose. Antenna robust, base of chela stout, thumb-like process short and narrowing, with inner distal flange, distal segment a stout claw with proximal inner spine. Mouth tube broader than long, with lateral spiny bulge. Basal segment of maxilla short, distal regularly widening, ventral side with a patch of spinules, distal lobe hemispherical and spinulose, claw long. Basal segment of maxilliped prominently bulged internally, claw strongly curved.

Legs one to four with three-segmented rami. Segments of both rami of all the legs except the first exopod segment rounded, with broad outer flange, endopod segments hairy but not spiny, claws on exopod with broad wings.

*Length.*—10.0 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 2+0, 6+0 | 1+I, 1+I, 4+II |
| Leg 2 | 1+0, 2+0, 6+0 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 1+0, 4+I | 1+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, 3+I | 1+I, 1+I, 4+III |

*Male.*—Cephalothorax narrower than in female. Cephalic processes stouter but shorter. Fourth thoracic segment roughly squarish. Fifth segment not fused with genital segment, latter narrowing. Abdomen long and three-segmented, narrowing. Caudal rami as long as anal segment. Appendages as in female.

*Length.*—8.4 mm.

*Host.*—*Galeocerdo cuvieri.*

*Distribution.*—Peurto Rico, Florida, Madagascar.

*Remarks.*—This species can be easily distinguished by the shape of the maxilliped and the fourth thoracic segment. The legs show equally diagnostic features. In other species the second endopod segment of legs one and two has one seta or none. In *K. dispar* there are two setae and the first seta is very small. The spines on the exopod segments are leaf-like. The third exopod segment of legs three and four has the penultimate seta converted into an asymmetrically winged spine which is unusual.

**Kroyeria gemursa** Cressey
(Figs. 235, 236 E-H, 237 A-B)

*Kroyeria gemursa* Cressey, 1967b, p. 15, fig. 5, 43-53 ; 1970, p. 17, fig. 59.

*Female.*—Cephalothorax nearly equal in length and width, with distinct antennular lobe, postero-lateral lobes very small, not reaching the hind border of the median lobe. Cephalic processes slender and long, reaching the hind border of the fourth thoracic segment, apically asymmetrically forked, tips of the fork rounded. Thoracic segments two to four successively increasing in length and decreasing in width. Genital segment very long, more than half the total length of body. Abdomen apparently three-segmented, position of third segment indicated by extra chitinisation, distal part of third segment strongly chitinised and forming prominent bulgings. Caudal rami with two short and two long setae and two stout spines.

Antennule slender, seven-jointed and sparsely setose, first segment long. Basal segment of antenna produced into a short stout thumb with inner flange, distal segment similar to thumb but basally broader, with a spine. Basal segment of maxilla short but stout, distal broadening, with prominent spiny bulge and bunch of hairs, the spines extend on to the inner border of the segment, claw stout, apically blunt and with prominently serrate margin. Proximal inner part of basal segment of maxilliped prominently bulging, distal segment strongly curved, reaching the base of the basal segment.

Intercoxal plate of first legs with a conical projection instead of the usual process. Rami subequal, second and third segments of

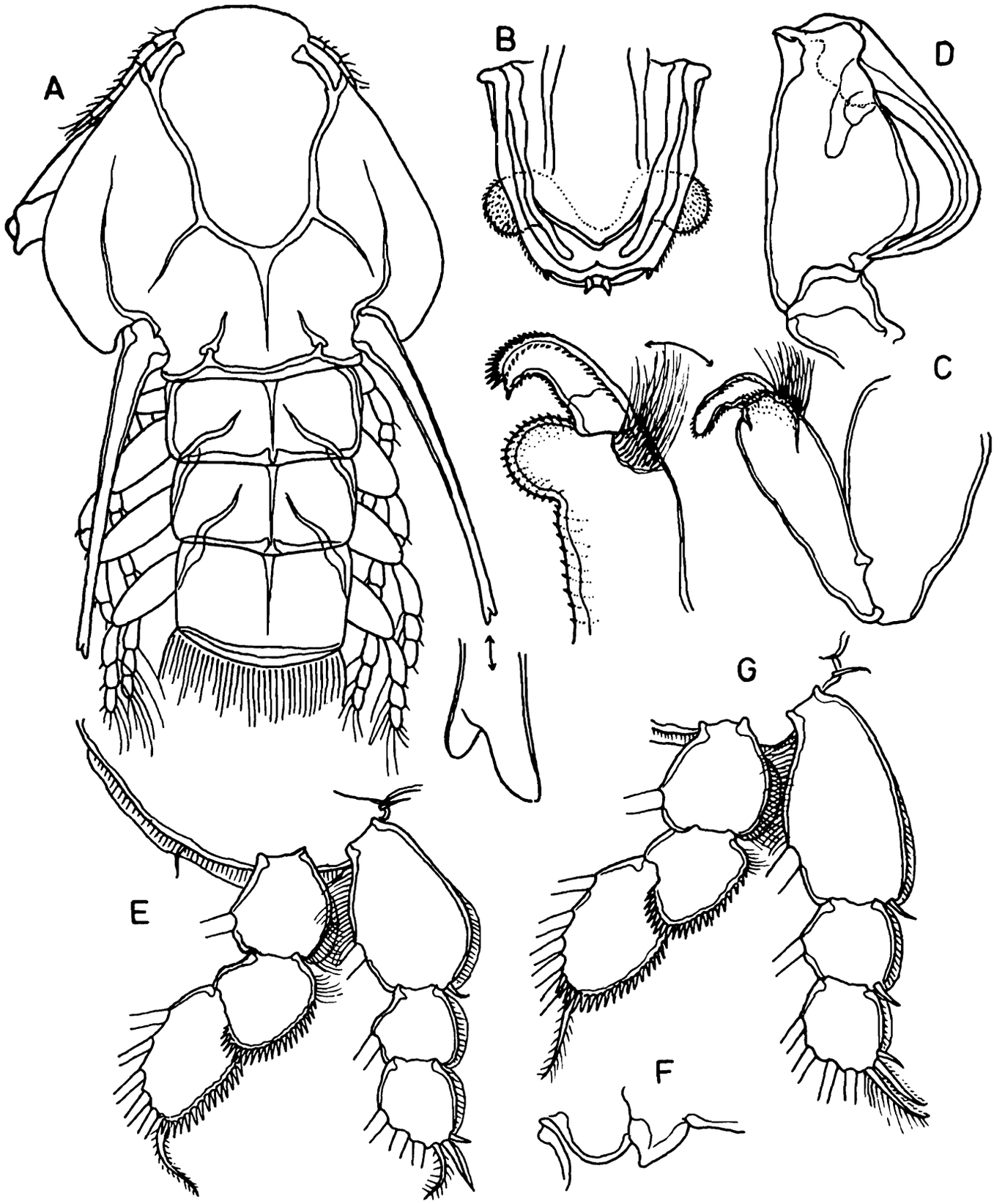


Fig. 235. *Kroyeria gemursa* Cressey : A, female, anterior part of body ; B, labrum ; C, maxilla ; D, maxilliped ; E, leg 1 ; F, process on intercoxal plate ; G, leg 2

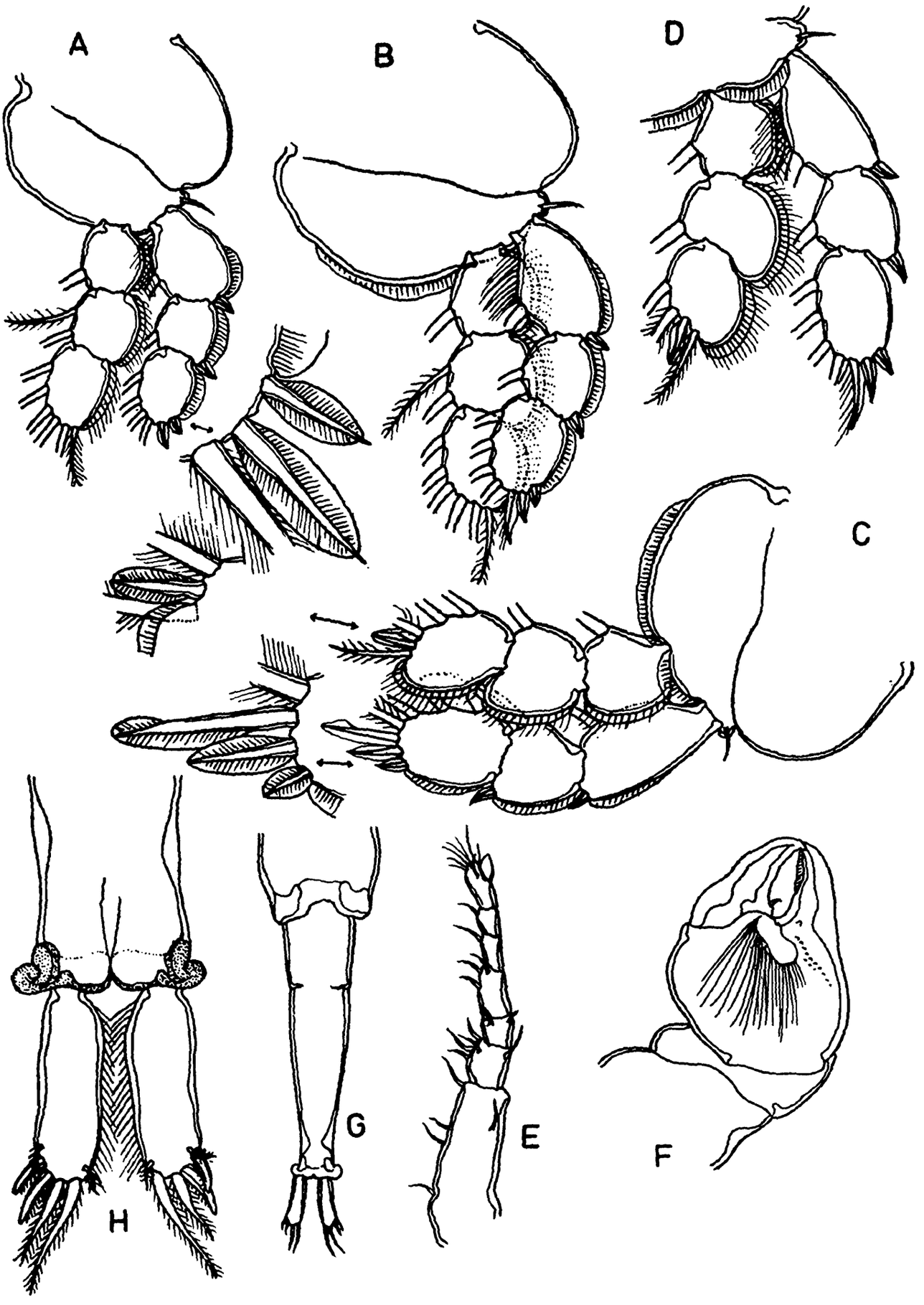


Fig. 236. *Kroyeria dispar* (contd.) : A-D, legs 1-4 ; E-H, *Kroyeria gemursa* (contd.) : E, antennule ; F, antenna ; G, abdomen ; H, same, tip enlarged.

endopod with a long row of closely packed sharp teeth numbering up to twenty five. Second leg similar to first but the first exopod segment much longer. Third and fourth legs similar to second but the first exopod segment progressively increasing in length. Processes on intercoxal plates successively increasing in length.

*Length.*—9.7 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 0+0, 6 | 1+I, 1+0, 4+II |
| Leg 2 | 1+0, 0+0, 6 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 0+0, 4 | 1+I, 1+I, 5+II |
| Leg 4 | 1+0, 1+0, 3 | 1+I, 1+I, 4+III |

*Host.—Sphyrna mokarran.*

*Distribution.*—Madagaskar, Florida.

*Type* in the U. S. National Museum.

*Remarks.*—Compared to the description by Cressey some minor differences were observed. The abdomen is three-jointed and the bulgings at the hind end are slightly different in shape. The distal segment of the maxilla has a prominent spiny bulge and the apex of the claw is well armed.

The apical forking of the cephalic processes, the bulgings on the oral tube, the sclerotisation of the tip of the abdomen, the absence of processes on the first intercoxal plate and the long row of spines on the endopod of the legs distinguish this species.

**Kroyeria gracilis** Wilson
(Figs. 237 C-K, 238 A-C)

*Kroyeria gracilis* Wilson, 1932, p. 453, pl. 29 ; Yamaguti, 1963, p. 163 ; Cressey, 1967b, p. 13 ; 1970, p. 17.

*Female.*—Cephalothorax broader than long, frontal lobe distinct, postero-lateral lobes narrow and acute, postero-median lobe broad and convex. Cephalic processes rather short, overreaching third

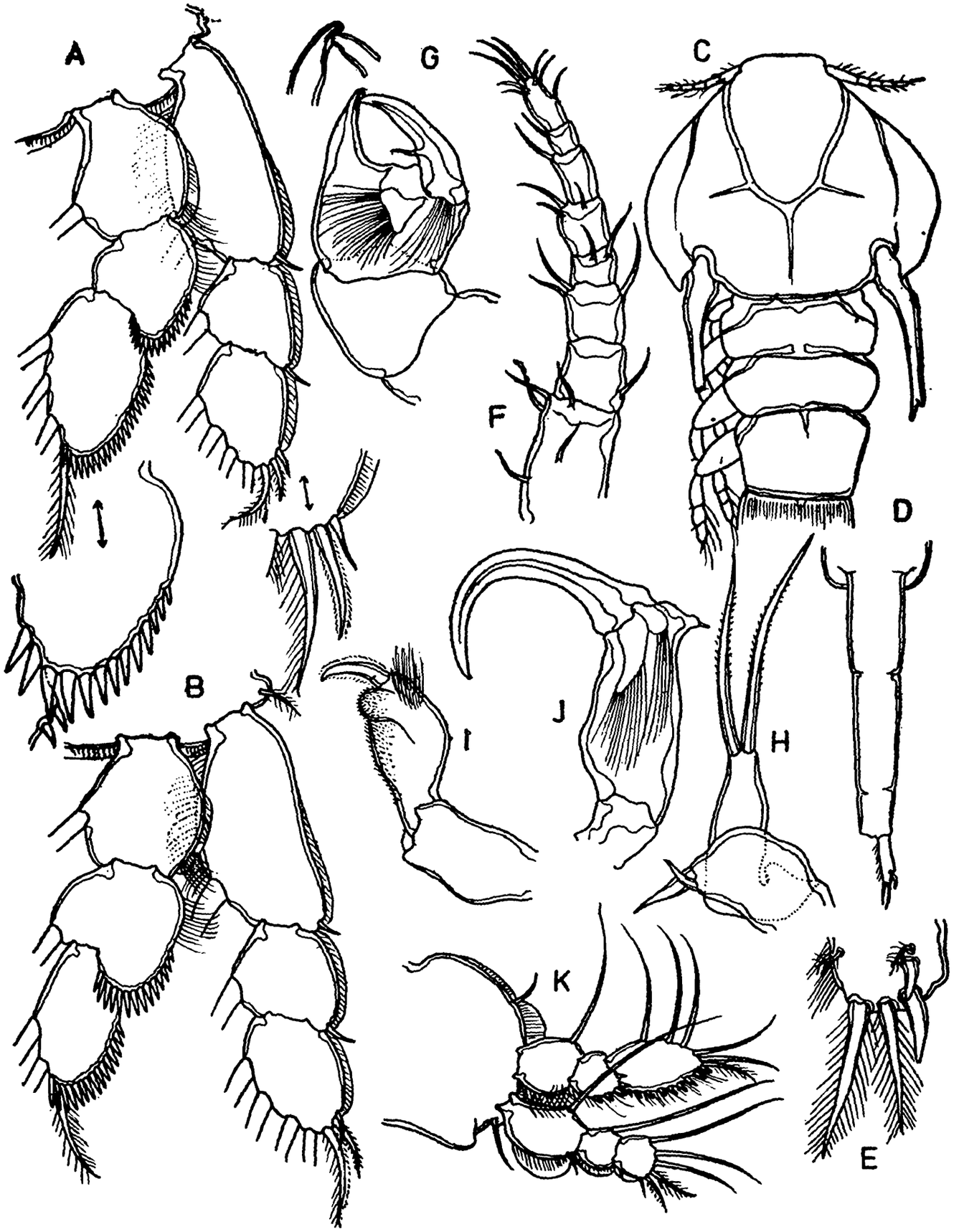


Fig. 237. *Kroyeria gemursa* (contd.) : A, leg 3 ; B, leg 4 ; C-K, *Kroyeria gracilis* Wilson : C, female, anterior end of body; D, abdomen; E, caudal ramus; F, antennule ; G, antenna ; H, maxillule ; I, maxilla ; J, maxilliped ; K, leg 1.

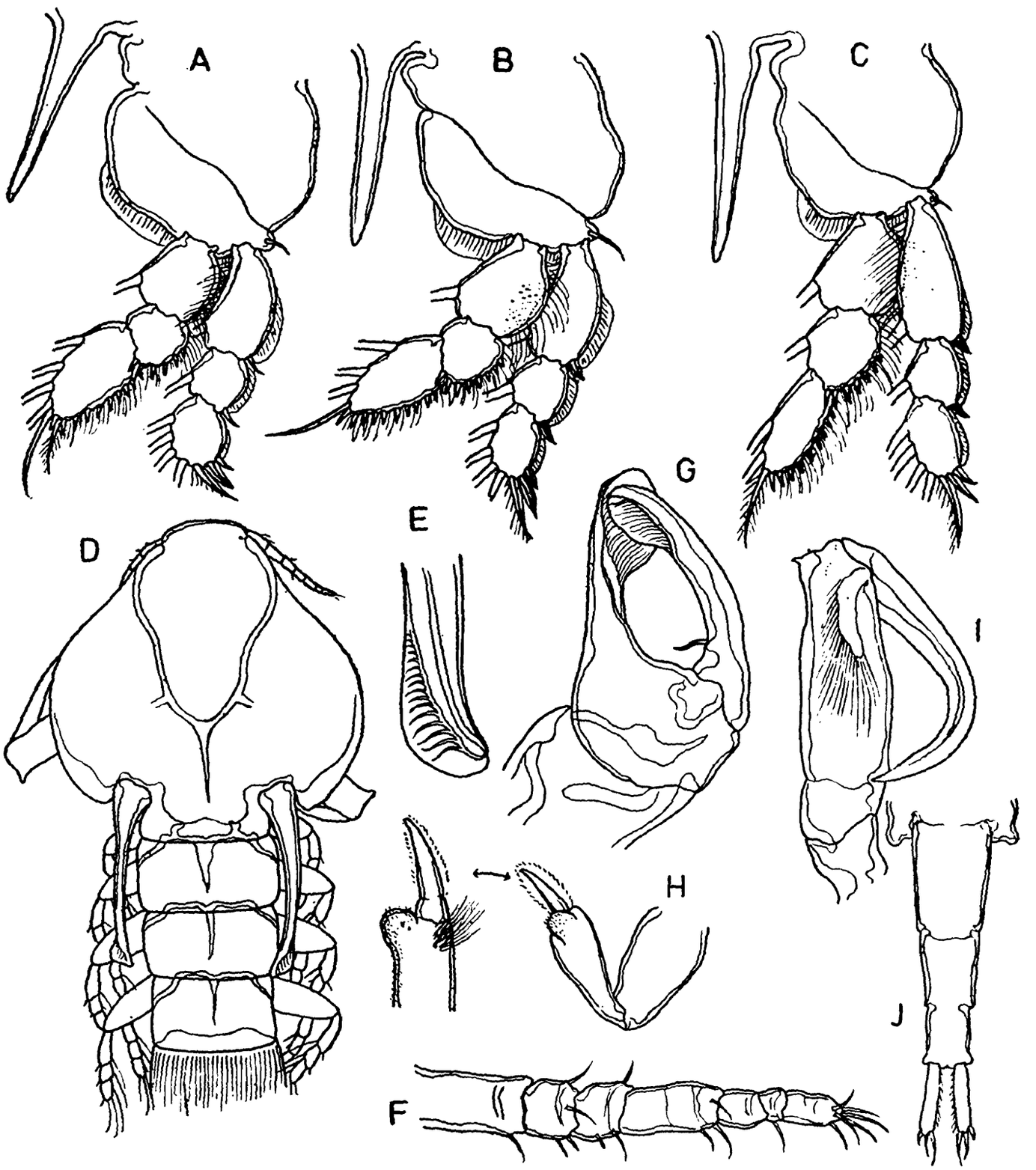


Fig. 238. *Kroyeria gracilis* (contd.) : A-C, legs 2-4 : D-J, *Kroyeria spatulata* Pearse : D, female, anterior end of body ; E, tip of cephalic process ; F, antennule ; G, antenna ; H, maxilla ; I, maxilliped ; J, abdomen.

thoracic segment, with small proximal outer bulge and subapical outer lobe. Second thoracic segment anteriorly constricted, third

segment as broad as second, fourth much longer than third and narrowing. Abdomen long and slender, second segment longest. Caudal rami with two small setae, two long setae and two stout spines.

Antennule comparatively stout, eight-segmented, first segment very large. Antenna moderate in size, second segment produced into a fairly stout apically hollowed thumb, distal segment rather slender, with basal inner seta. Inner lobe of maxillule with two short spines, outer with two long spines. Maxilla comparatively small, segments irregular in outline, distal segment with moderately large lobe, ventral surface spinulose, claw with broad flange and a basal partition. Basal segment of maxilliped only slightly bulged on the inner side, outer distal part prominently produced, claw elaborately curved.

Exopod segments of legs with broad outer wing and second and third endopod segments with prominent spines, third endopod segment elongated.

*Length.*—10.5 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 0+0, 6 | 1+I, 1+0, 4+II |
| Leg 2 | 1+0, 0+0, 6 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 0+0, 4 | 1+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, 3 | 1+I, 1+I, 4+III |

*Host.—Carcharhinus milberti, C. obscurus, C. leucas, C. longimanus, Galeus glaucus, Carcharias commersoni, C. limbatus, Sphyrna zygaena, Aprionodon isodon, Scoliodon terrae-novae.*

*Distribution.*—Woods Hole, Madagascar, Florida, Gulf of Mexico, Dry Tortugas (probably cosmopolitan).

*Remarks.*—According to Delamare-Deboutteville and Nunes-Ruivo (1954) and Shiino (1957c) *K. gracilis* is a synonym of *K. carchariae-glauci* Hesse. Considering the description given by Shiino this may well be so. Shiino's description clearly applies to my specimen. Cressey apparently maintains its separate identity.

I had only a single female to study and I leave the question of its synonymy open.

## **Kroyeria spatulata** Pearse
(Figs. 238 D-J. 239)

*Kroyeria spatulata* Pearse, 1948, p. 127, 1952, p. 30 ; Yamaguti, 1963, p. 163 ; Cressey, 1967b, p. 14 ; 1970, p. 18, fig. 60.
*Kroyeria elongata* Pillai, 1967b, p. 290, figs. 12-34.

*Female*.—Cephalothorax slightly longer than broad, with distinct antennal lobe, postero-lateral lobes short and rounded, postero-median lobe projecting well beyond the lateral. Cephalic processes just reaching the hind border of the third thoracic segment, apically flattened and curving inwards. Thoracic segments two and three subsimilar, fourth narrower and longer. Genital segment three times as long as the body in front. Abdomen three-segmented, segments successively decreasing in length and width. Caudal rami longer than anal segment, with two long setae, a large spine, a small spine and two small setae.

Antennule broad throughout, seven-segmented. Chela of antenna elongated, base of the chela short, thumb stout and apically highly flattened, distal segment slender, apically moderately flattened. Maxilla small, basal segment slightly stouter than distal, latter with small lobe, claw nearly straight, with broad flange. Basal segment of maxilliped with nearly subparallel sides, distal segment comparatively stout.

Legs with subequal rami, exopod segments with outer wing, second and third endopod segments with a few well spaced teeth, not exceeding six.

*Length*.—2.7 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 0+0, 6 | 1+I, 1+0, 3+III |
| Leg 2 | 1+0, 0+0, 6 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 0+0, 4 | 1+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, 2+1 | 1+I, 1+0, 4+II |

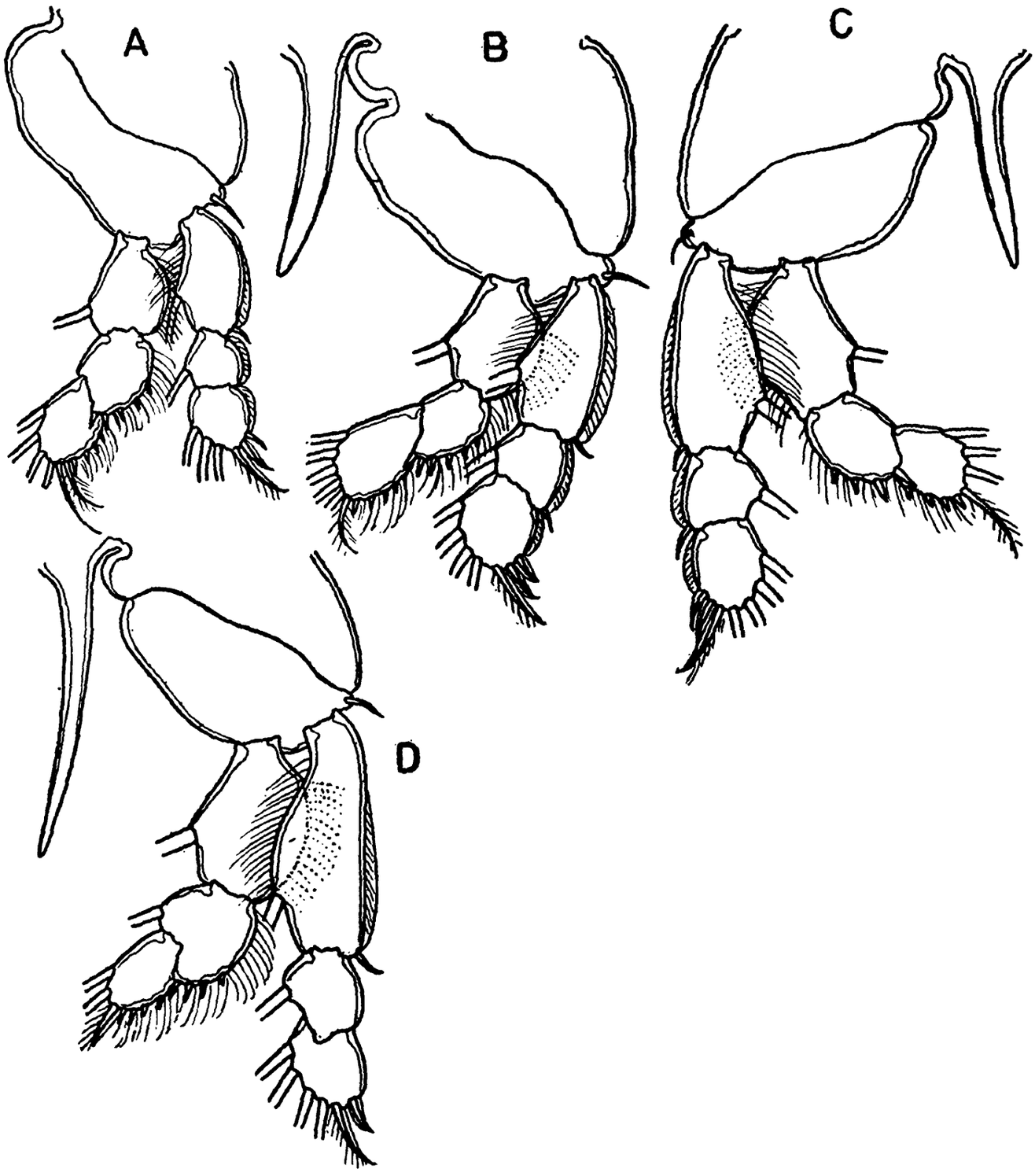


Fig. 239. *Kroyeria spatulata* (contd.) : A-D, legs 1-4.

*Male*.—Cephalothorax much broader than long. Cephalic processes short but stout, just overreaching hind border of second thoracic segment, with proximal outer subsidiary process. Third thoracic segment appreciably longer than others. Genital segment

as long as the combined length of the free thoracic segments. Fifth segment free. Abdomen long, streadily narrowing, second segment short, others subequal in length. Caudal rami as long as anal segment.

*Length.*—2.6 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 0+0, 6 | 1+I, 1+0, 4+II |
| Leg 2 | 1+0, 0+0, 6 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 0+0, 4 | 1+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, 3 | 1+I, 1+I, 4+III |

*Host.*—*Scoliodon terrae-novae*, *S. sorrakowah*, *Carcharias littoralis*, *Carcharhinus limbutus*, *C. maculipinnis*, *C. sorrah*, *C. leucas*, *Rhizoprionodon acutus*, *Negaprion brevirostris*.

*Distribution.*—Gulf of Mexico, Texas, Bahamas, Western Australia, Madagascar, India (Kerala).

*Remarks.*—This species can be easily distinguished by the apically flattened cephalic processes of the female and the short stout process of the male having an outer basal lobe. The comparatively long chela of the antenna with both finger and thumb apically flattened is also diagnostic.

**Kroyeria longicauda** Cressey
(Figs. 240, 241 A-C)

*Kroyeria longicauda* Cressey, 1970, p. 19, figs. 64-77.

*Female.*—Cephalothorax nearly as long as broad, posterolateral lobes blunt, slightly overreaching distal border of median lobe. Cephalic processes long and slender, with an outer lobe situated away from the tip, reaching the middle of the fourth thoracic segment. Thoracic segments two to four successively increasing in length and decreasing in width. Genital segment about two thirds the total length of body, with a small segment demarcated anteriorly. Abdomen three-segmented, third segment longer than second. Caudal rami slightly longer than anal segment,

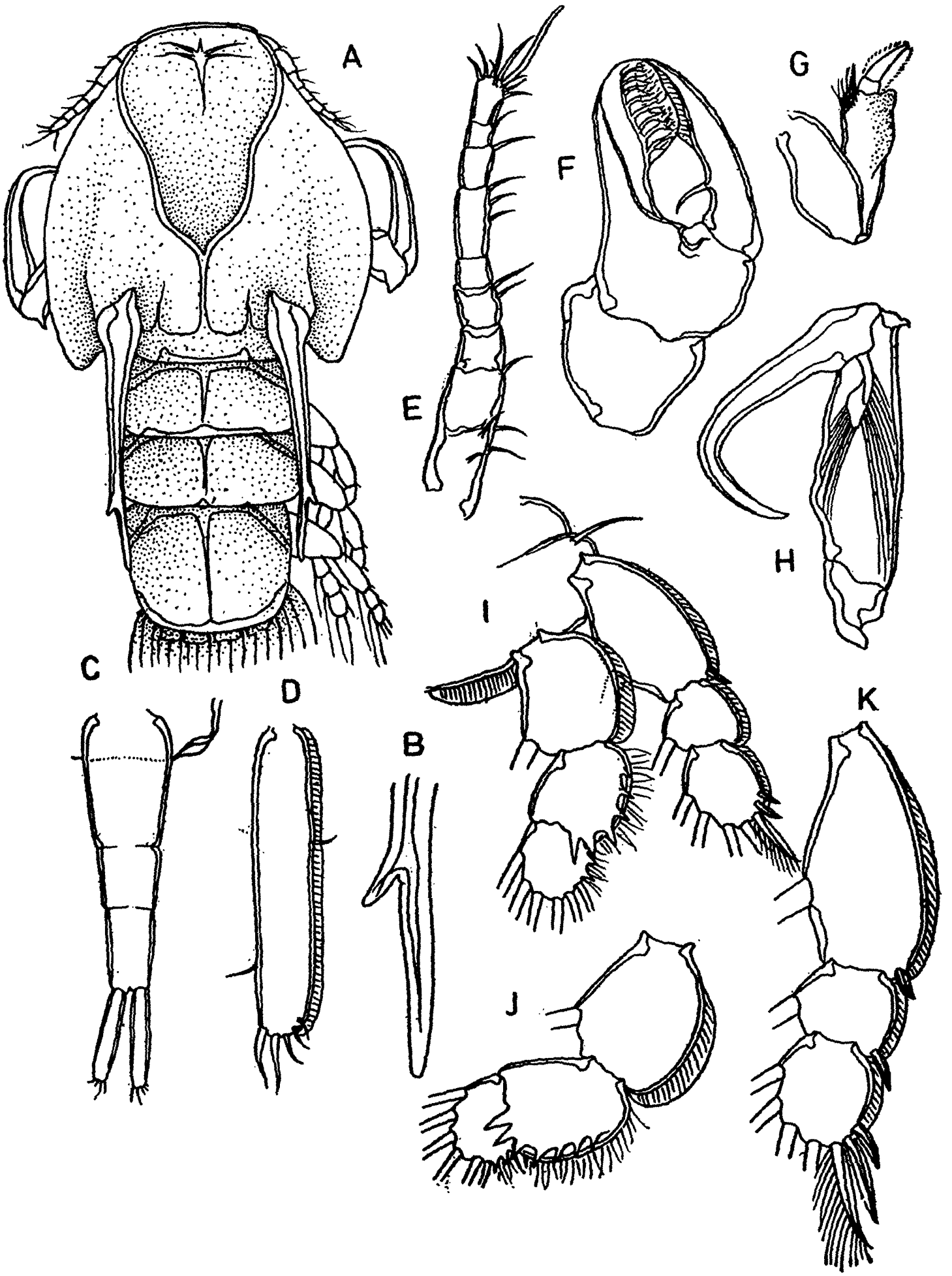


Fig. 240. *Kroyeria longicauda* Cressey : A, female, anterior end of body ; B, tip of cephalic process ; C, abdomen ; D, caudal ramus ; E, antennule ; F, antenna ; G, maxilla ; H, maxilliped ; I, leg 1 ; J, leg 2, endopod ; K, same, exopod.

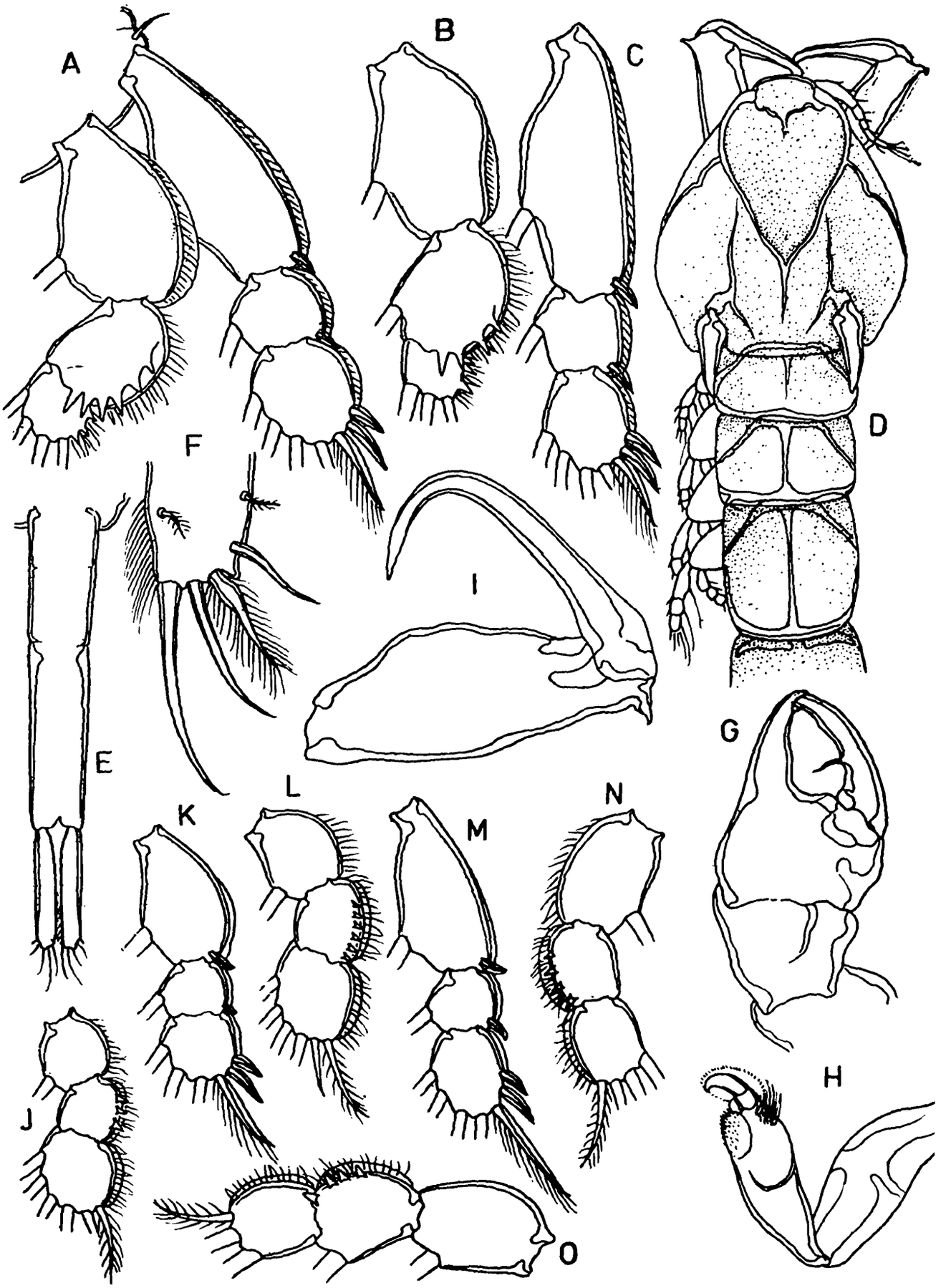


Fig. 241. *Kroyeria longicauda* (contd.) : A, leg 3 ; B, leg 4, endopod ; C, same, exopod : D-O, *Kroyeria echinata* Rangnekar : D, female, anterior end of body ; E, abdomen ; F, same, tip of caudal ramus ; G, antenna ; H, maxilla ; I, maxilliped ; J, leg 1, endopod ; K, same, exopod ; L, leg 2, endopod ; M, same, exopod ; N, leg 3, endopod ; O, leg 4, endopod.

with one inner and one outer seta, five distal setae and an outer membrane extending the entire length.

Antennule eight-jointed, basal segment long, distal with an aesthete. Chela of antenna rather elongated, with short base and long pincers, both distally flattened, exactly as in *K. spatulata*. Distal segment of maxilla ventrally spinulose, claw with basal partition and moderately broad flange. Basal segment of maxilliped with small inner bulge, claw very long and curved.

Exopods of legs one to four with moderately broad outer flange. second and third segments of endopod externally spiny, the number of spines not exceeding seven, spines large and not separated by a partion.

*Length.*—3.7 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 0+0, 6 | 1+I, 1+0, 4+III |
| Leg 2 | 1+0, 0+0, 6 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 0+0, 4 | 1+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, 3 | 1+I, 1+I, 4+III |

*Host.—Carcharhinus limbatus.*

*Distribution*—Florida, India (Kerala).

*Type* in the U. S. National Museum.

*Remarks.*—This small species can be easily identified by the position of the accessory lobe on the cephalic processes, the presence of an outer flange on the caudal rami and the absence of spines on the apex of the caudal rami. The small number of large spines on the endopods of the legs is also characteristic.

**Kroyeria echinata** Rangnekar
(Fig. 241 D-O)

*Kroyeriá echinata* Rangnekar, 1956, p. 57, figs. a-k.

*Female.*—Cephalothorax rather elongated, with clearly marked narrow and projecting antennular lobe, postero-lateral lobes very

small, postero-median lobe slightly projecting beyond lateral lobes. Cephalic processes very short and unusually stout, reaching slightly beyond the middle of the second thoracic segment. Thoracic segments successively increasing in length, fourth comparatively very long. Abdomen apparently three-segmented but first septum indistinct. Caudal rami with four long and two small plumose setae, no spines, outer distal corner slightly produced.

Antennule slender and seven-jointed, basal segment large, distal with an aesthete. Chela of antenna stout, thumb apically slightly flattened, distal segment apically blunt. Distal segment of maxilla with a patch of spinules, no distinct lobe, claw stout and curved, with prominent flange. Basal segment of maxilliped internally bulged, outer distal process narrow but prominent, claw long, distally bent at right angles.

Endopod of first leg with subsimilar segments, second segment armed with three large teeth. Basal segment of exopod large. Second segment of endopod of legs two to four with six, four and four spines respectively. Basal exopod segment successively increasing in length. Intercoxal processes absent.

*Length.*—4.1 mm

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 0+0, 6 | 1+I, 1+I, 4+II |
| Leg 2 | 1+0, 0+0, 6 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 0+0, 4 | 1+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, 3 | 1+I, 1+I, 4+III |

*Host.*—*Sphyrna zygaena.*

*Distribution.*—India (Bombay, Kerala).

*Remarks.*—Rangnekar has described a pair of dorsal plates on the free thoracic segments. There are no dorsal plates but the chitinous ribs on the ventral side giving attachment to muscles show through the body and appear as dorsal plates. She has described the caudal rami as tubular. But they are dorso-ventrally

flattened as usual. Rangnekar does not mention the number of spines on the endopod segments. Her figures show more spines than are actually present. The short but stout cephalic processes distinguish this species.

## **Kroyeria sphyrnae** Rangnekar
(Fig. 242)

*Kroyeria sphyrnae* Rangnekar, 1957a, p. 14, fig. 4 ; Pillai, 1967b, p. 286, figs. 1-11 ; Cressey, 1970, p. 18 ; Kabata, 1970b, p. 165.

*Female.*—Cephalothorax slightly longer than broad, with small but distinct antennular lobe. Postero-lateral lobes short, not reaching the hind border of the median lobe, latter evenly convex. Cephalic processes very long, overreaching the hind border of the fourth thoracic segment. Thoracic segments two and three subsimilar, fourth longer, and nearly equal in width. Genital segment seven to eight times the length of the free thoracic segments. Abdomen long elliptic, three-segmented, first and second segments subequal in length, third shorter. Caudal rami as long as second abdominal segment, with two large plumose setae and two curved spines, outer border with a spinule.

Antennule very slender, eight-jointed. Antenna stout, thumb distally spooned, distal segment stout and well curved, tip strongly chitinised. Basal segment of maxilla subequal to distal, latter with broad inner flange and small distal bulge, claw with distinct partition and fairly broad flange. Basal segment of maxilliped not much enlarged, claw stout, apically well chitinised.

Legs one to four seccessively increasing in length, outer border of exoped segments with narrow flange, that of endopod segments hairy, second and third segments spiny, spines not exceeding seven. Processes on intercoxal plates short, subequal in length.

*Length.*—4.7 mm.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 0+0, 6 | 1+I, 1+0, 4+II |
| Leg 2 | 1+0, 0+0, 6 | 1+I, 1+I, 4+III |
| Leg 3 | 1+0, 0+0, 4 | 1+I, 1+I, 4+III |
| Leg 4 | 1+0, 1+0, 3 | 1+I, 1+I, 4+II |

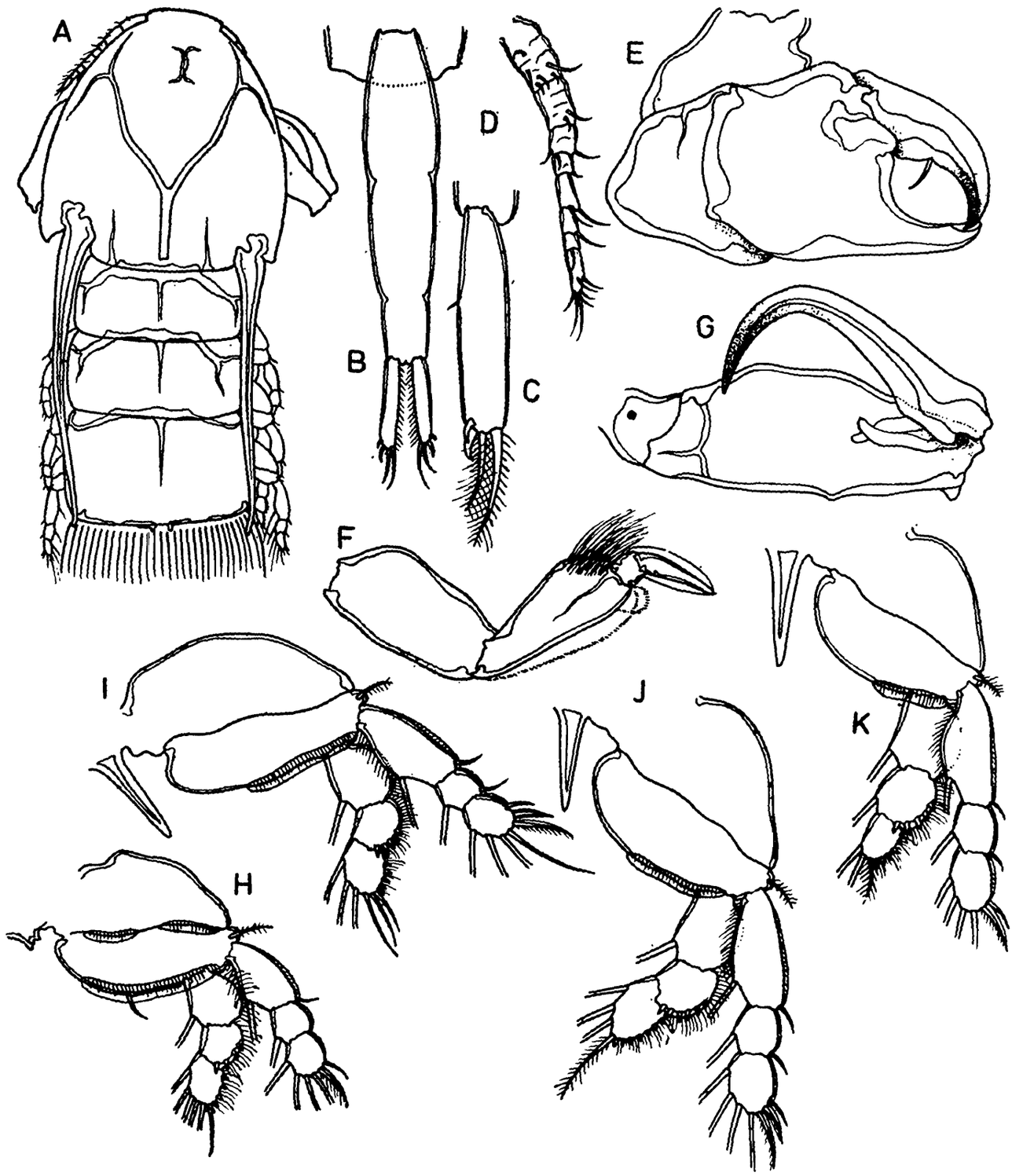


Fig. 242. *Kroyeria sphyrnae* Rangenkar : A, female, anterior part of body ; B, abdomen ; C, caudal ramus ; D, antennule ; E, antenna ; F, maxilla; G, maxilliped ; H-K, legs 1-4.

*Host.*—*Sphyrna zygaena, Carcharhinus acronotus.*

*Distribution.*—India (Bombay, Kerala), Florida, Australia.

*Remarks.*—As observed by Kabata the original description of this species by Rangnekar lacks all essential details. Kabata observed that the length of the cephalic processes has only doubtful diagnostic value. But in *K. sphyrnae* the processes are very long and provide a useful diagnostic character.

## **Kroyeria minuta** Pillai
(Fig. 243)

*Kroyeria minuta* Pillai, 1968b, p. 21. figs. 6-7.

*Female.*—Cephalothorax broader than long, postero-lateral lobes small, angular and remaining apart from the cephalic processes. Postero-median lobe comparatively narrow, with evenly convex border. Cephalic processes long, not reaching hind border of fourth thoracic segment, apically forked. Thoracic segments subequal in length and width. Genital segment three times as long as the body in front. Abdomen short, without segmentation, constricted at the distal third. Caudal rami half the length of abdomen, with two setae and two long spines.

Antennule eight-jointed. Chela of antenna comparatively small, thumb slender and apically spooned, distal segment with two basal and one median seta. Maxilla very slender, claw apically forked. Basal segment of maxilliped slightly bulging in the middle, distal segment stout, with a row of tubercles.

Exopod of first leg with narrow flange, no spines, second and third endopod segments with a small number of teeth, apparently serrations and not true teeth. Exopod of second leg also without spines, middle segment serrated. First and second segments of third and fourth legs with a spine, third segment with none. Rami of legs and processes on intercoxal plates successively increasing in length.

*Length.*—3.0 mm.

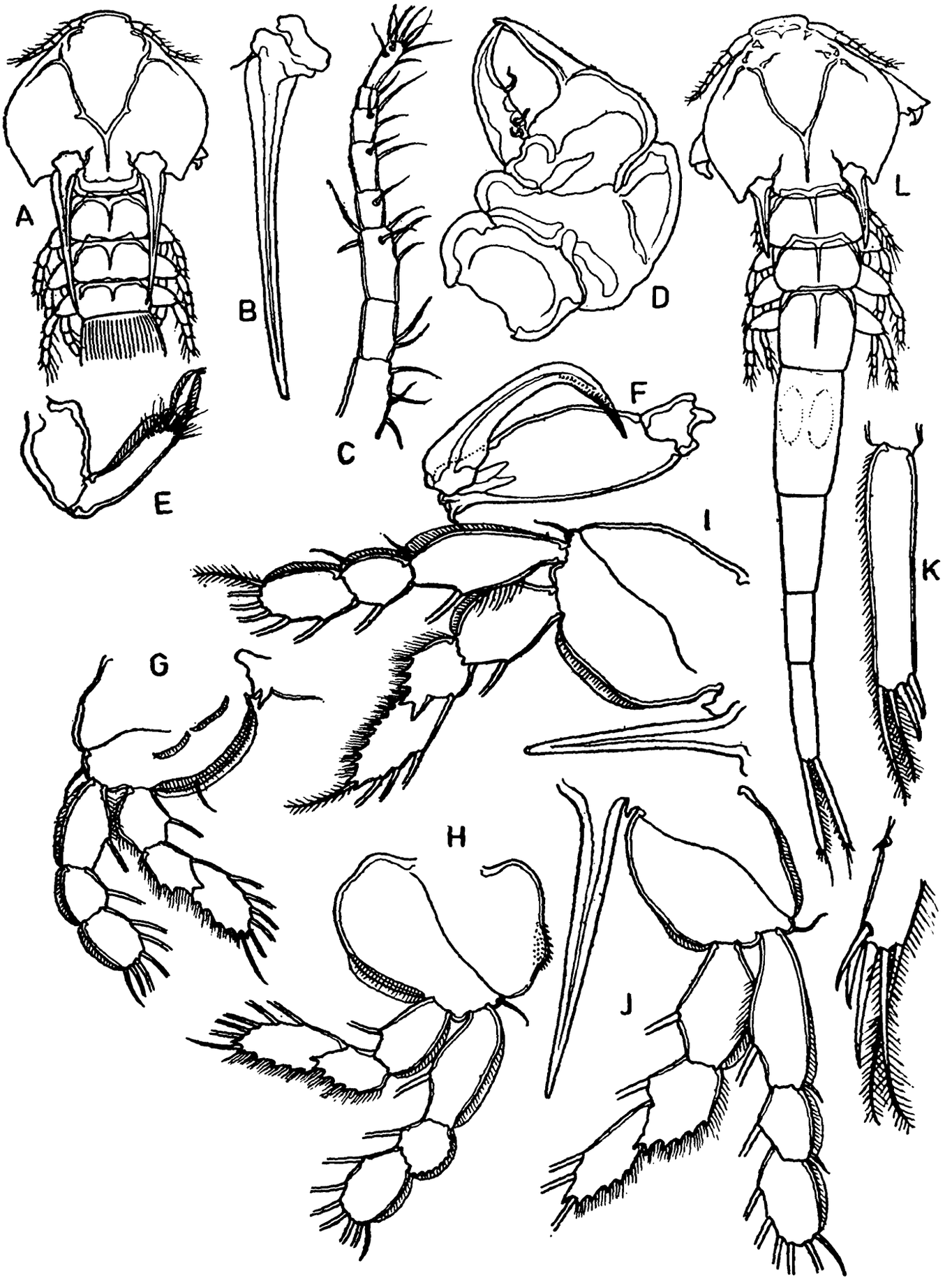


Fig. 243. *Kroyeria minuta* Pillai : A-K, female ; A, female, dorsal view ; B, cephalic process ; C, antennule ; D, antenna ; E, maxilla ; F, maxilliped ; G-J, legs 1-4 ; K, caudal ramus ; K, male, dorsal view.

| | Endopod | Exopod |
|---|---|---|
| Leg 1 | 1+0, 0+0, 6 | 1+0, 1+0, 6 |
| Leg 2 | 1+0, 0+0, 6 | 1+0, 1+0, 7 |
| Leg 3 | 1+0, 0+0, 4 | 1+1, 1+1, 6 |
| Leg 4 | 1+0, 1+0, 3 | 1+I, 1+I, 6 |

*Male.*—Cephalothorax as in female. Cephalic processes short, just overreaching second thoracic segment, apex not forked. Thoracic segments successively decreasing in width, third shortest. Genital segment short, as long as the combined length of thoracic segments three to four. Abdomen long, slender, three-segmented. Caudal rami long and slender, with two long setae and three long spines.

*Length.*—2.0 mm.

*Host.*—*Scoliodon sorrakowah.*

*Distribution.*—India (Kerala).

*Type* in the National Zoological Collections at Zoological Survey of India, Calcuta, Reg. No. C 2162/2.

*Remarks.*—The armature of the legs of this species is very peculiar and easily distinguishes it. The endopod segments are serrated and not spiny as usual.

## Family PSEUDOCYCNIDAE

*Diagnosis.*—Cephalon fused with first thoracic segment to form a cephalothorax. Thoracic segments two and three clearly marked though partially fused, fourth, fifth and genital segments fused into a long cylindrical trunk. Abdomen short, one-segmented, fused with trunk. Caudal rami large and fleshy, fused with abdomen.

Antennule cylindrical. Antenna prehensile. Maxilliped stout, prehensile. Legs highly modified, first and second biramous, third uniramous, fourth and fifth setiform.

Male with pronounced sexual dimorphism in the shape of the body.

Parasites of teleosts.

Type genus.—*Pseudocycnus* Heller.

*Discussion*—Yamaguti included in this family five genera namely, *Bassettithia* Wilson (1922), *Pseudocycnus* Heller (1868), *Pseudocycnopsis* Yamaguti (1963), *Pseudocycnoides* Yamaguti (1963) and *Pseudoclavella* Bassett-Smith (1898b). He considered *Cybicola* Bassett-Smith as valid but removed it to Dichelesthiidae. Heegaard (1962) created *Paracycnus* and suggested that Cycnidae Kroyer (1863) should replace the family name Pseudocycnidae.

Yamaguti created *Pseudocycnoides* to describe *P. armatus* which according to him differs from *P. appendiculatus* in its second thoracic segment alone being free, first and second legs being biramous, third leg uniramous and fourth absent. He further observed that its third and fourth segments possess digitiform lateral processes which are absent in *P. appendiculatus*. My study has shown that the differences mentioned are either not present or are not of generic status. *Pseudocycnoides* is therefore treated as a synonym of *Pseudocycnus* (see below).

Yamaguti created *Pseudocycnopsis* to accommodate *P. buccatus* Wilson (1922). Wilson described this species thus" first leg mere knobs, second leg a bilobed lamina, suggesting two rami, third a short wide lamina and fourth obsolete" Yamaguti interpreted this as "all first three pairs of legs rudimentary, fourth leg entirely lacking" which is far different from what Wilson has written. Wilson's description is clearly applicable to *P. appendiculatus* as its first leg is bud-like. *Pseudocycnopsis* is not different from *Pseudocycnus*.

I have already shown that *Pseudoclavella* is a synonym of *Hatschekia* (Pillai, 1969).

The available description of *Basettithia* (Stebbing 1900) is not at all informative. Pending redescription of this species *Bassettithia* is treated as a doubtful synonym of *Pseudocycnus*.

Heegaard (1962) observed that *Paracycnus* closely resembles *Cycnus*, *Helleria* and *Pseudocycnus*. *Cycnus* and *Helleria* have long back been abandoned. Heegaard's description of the species contains so many obvious defects that one is inclined to suspect that he has described *P. armatus*.

From the above discussion it would appear that family Pseudocycnidae contains the single genus *Pseudocycnus*, the status of *Bassettithia* alone being doubtful.

## Genus **Pseudocycnus** Heller

*Pseudocycnus* Heller, 1868, p. 218 ; Tripathi, 1962a, p. 212 ; Silas and Ummerkutty, 1967, p. 925, 986.
*Helleria* Bassett-Smith, 1898a, p. 11.
*Cybicola* Bassett-Smith, 1898c, p. 371.
*Paracycnus* Heegaard, 1962, p. 181 ; Silas and Ummerkutty, 1967, p. 986.
*Pseudocycnoides* Yamaguti, 1963, p. 171.
*Pseudocycnopsis* Yamaguti, 1963, p. 172.
? *Bassettithia* Wilson, 1922, p. 72.

*Diagnosis.*—Cephalothorax as broad as or slightly broader than trunk. Thoracic segments two and three variously fused, fourth, fifth and genital segments completely fused to form an elongated cylindrical trunk. One or more of the free segments laterally drawn out into digitiform processes.

Antennule cylindrical, sparsely setose. Antenna prehensile. Maxillule a chitinised process carrying two spines. Maxilla two-joined, distal segment with spines or teeth, unguis indistinct. Maxilliped stout and prehensile. Legs one and two biramous, first slightly deformed, third uniramous, fourth and fifth if present setiform.

Cephalothorax of male broader than trunk, latter more or less segmented. Legs one and two biramous, others as in female.

Type species.—*P. appendiculatus* Heller.

Parasites of teleosts (scomberoids).

*Key to species of* **Pseudocycnus**

1. Thoracic segments three and four with projecting lateral processes, caudal rami less than half the length of trunk, fourth leg of male setiform — *armatus* (Bassett-Smith)
— Thoracic segments three and four without projecting lateral processes, caudal rami more than half the length of trunk, fourth leg of male mounted on a long stout base — *appendiculatus* Heller

## **Pseudocycnus appendiculatus** Heller
(Fig. 244)

*Pseudocycnus appendiculatus* Heller, 1868, p. 218, pl. 22, fig. 7 ; Wilson, 1922, p. 75, pl. 2, figs. 87-96; Kirtisinghe, 1935, p. 339, figs. 10-28 ; Shiino, 1959d, p. 325, figs. 24-25 ; Yamaguti, 1963, p. 170, pl. 197, fig. 2 ; Pillai, 1964b, p. 73, figs. 83-94 ; Hewitt, 1969a, p. 169, figs. 1-11.

*Female.*—Cephalothorax clearly longer than broad, posterolaterally forming rounded lobes. Second thoracic segment as broad as cephalothorax, longer than third. Fourth segment fused with trunk, latter of the same width throughout, about four times as long as cephalothorax (length variable). Abdomen short, fused with trunk. Caudal rami about half the total length of body, fused with abdomen.

Antennule short, apparently four-jointed. Antenna three-jointed, third segment with proximal and median processes. Maxillule a chitinised process arising from a bilobed base and with two unequal apical spines. Basal segment of maxilla short but broad, distal segment distally expanded and strongly dentate. Distal segment of maxilliped with median and distal processes.

First leg indistinctly biramous, covered by a chitinous envelop, basipod externally produced, exopod with two and endopod with one spine. Second leg clearly biramous, rami with three teeth each. Third leg uniramous, with three teeth. Fourth and fifth legs setiform.

*Length.*—8-10 mm.

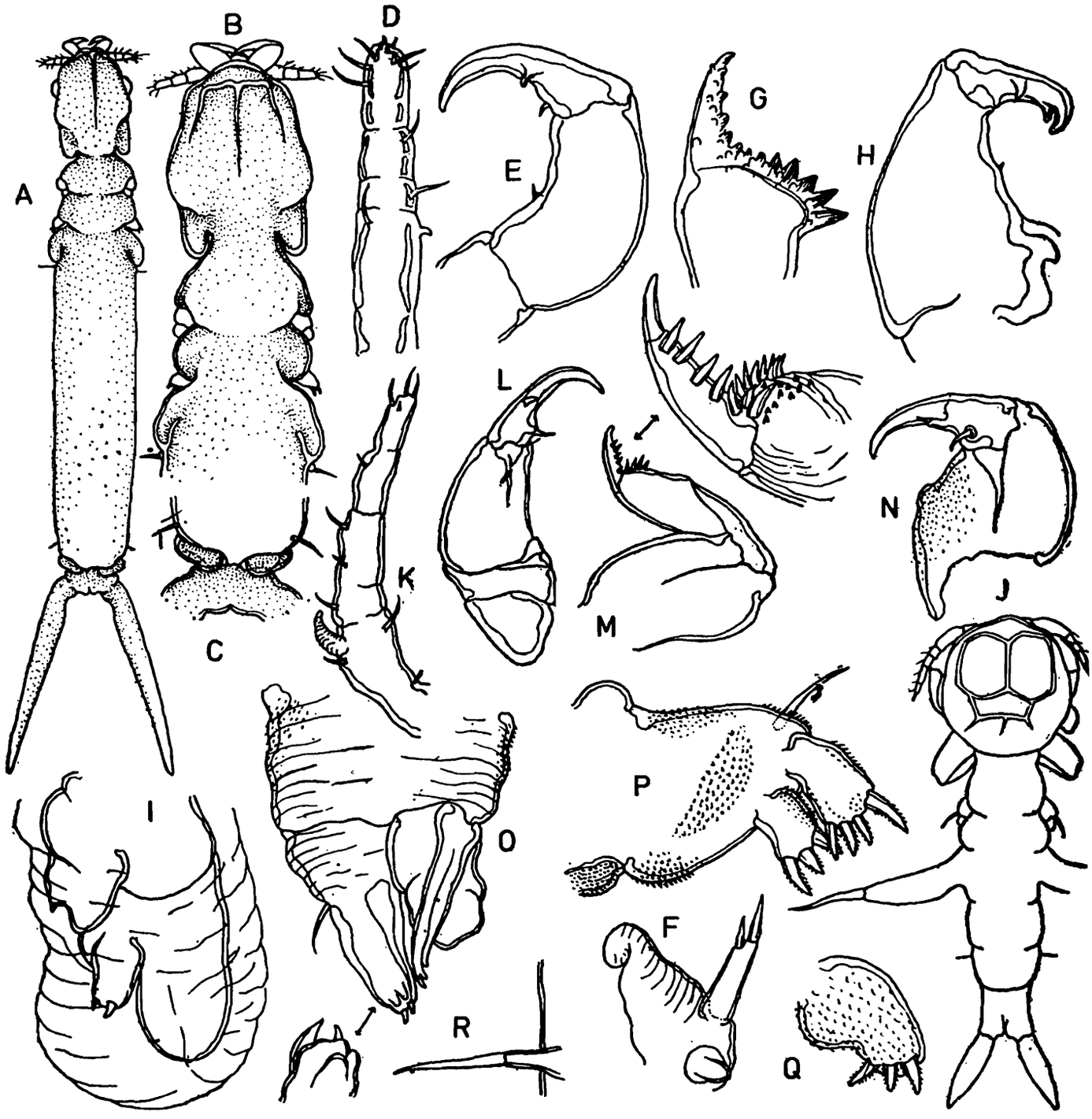


Fig. 244. *Pseudocycnus appendiculatus* Heller : A-I, Female. A, female, dorssal view ; B, anterior part of body ; C, posterior part of body ; D, antennule ; E, antenna ; F, maxillule ; G, maxilla ; H, maxilliped ; I, leg 1. J-R, Male : J, male, dorsal view ; K, antennule ; L, antenna ; M, maxilla ; N, maxilliped ; O, leg 1 ; P, leg 2 ; Q, leg 3 ; R, leg 4.

*Male.*—Cephalothorax nearly circular, much broader than trunk, second thoracic segment nearly twice as long as third. Fourth segment drawn out into stout long processes carrying the fourth legs. Fifth segment partially fused with genital segment, carrying

the setiform fifth legs. Abdomen distinct. Caudal rami longer than abdomen.

Antennule five to six-segmented, second segment with large process. Antenna three-jointed, narrowing, distal segment with two spines. Distal segment of maxilla with large teeth. Basal segment of maxilliped broad and internally pustulose, distal long and very slender. First leg clearly biramous, basipod with long chitinised stylet, other legs as in female.

*Length.*—2.7 mm.

*Host.—Thunnus thynnus, T alalunga, T albacares, T obesus, Katsuwonus pelamys, Sarda sarda, Euthynnus alleteratus, E. yaito, E. affinis.*

*Distribution.*—Cosmopolitan.

**Pseudocycnus armatus** (Bassett-Smith)
(Fig. 245)

*Pseudocycnus armatus*; Bassett-Smith, 1898c, p. 371; Kirtisinghe, 1937b, p. 453, figs. 1-11 ; Gnanamuthu, 1950g, p. 276, figs. 9-18; Pillai, 1964b, p. 75, figs. 95-108 ; Silas and Ummerkutty, 1967, p. 928, 986, figs. 15, 19.
*Helleria armata* Bassett-Smith, 1898a, p. 9, pl. 5, figs. 1-2.
*Cybicola armata* Bassett-Smith, 1898c, p. 371; Yamaguti, 1963, p. 135, pl. 171, fig. 1.
*Pseudocycnoides armatus* Yamaguti, 1963, p. 172, pl. 196, fig. 2.
*Paracycnus lobosus* Heegaard, 1962, p. 182, figs. 182-190; Kabata, 1970b, p. 171

*Female.*—Cephalothorax broader than long, postero-laterally produced into conical lobes and posteriorly narrowing to join the second thoracic segment, the stout maxillipeds visible between these two. Second trunk segment transversely oblong, third and fourth short, laterally drawn out into projecting lobes. Trunk about two thirds the total length of body minus the caudal rami. Caudal rami fused with abdomen, one and a half times as long as abdomen.

Antennule seven-segmented, second segment with curved dorsal process. Antenna slender, three-jointed, third segment strongly

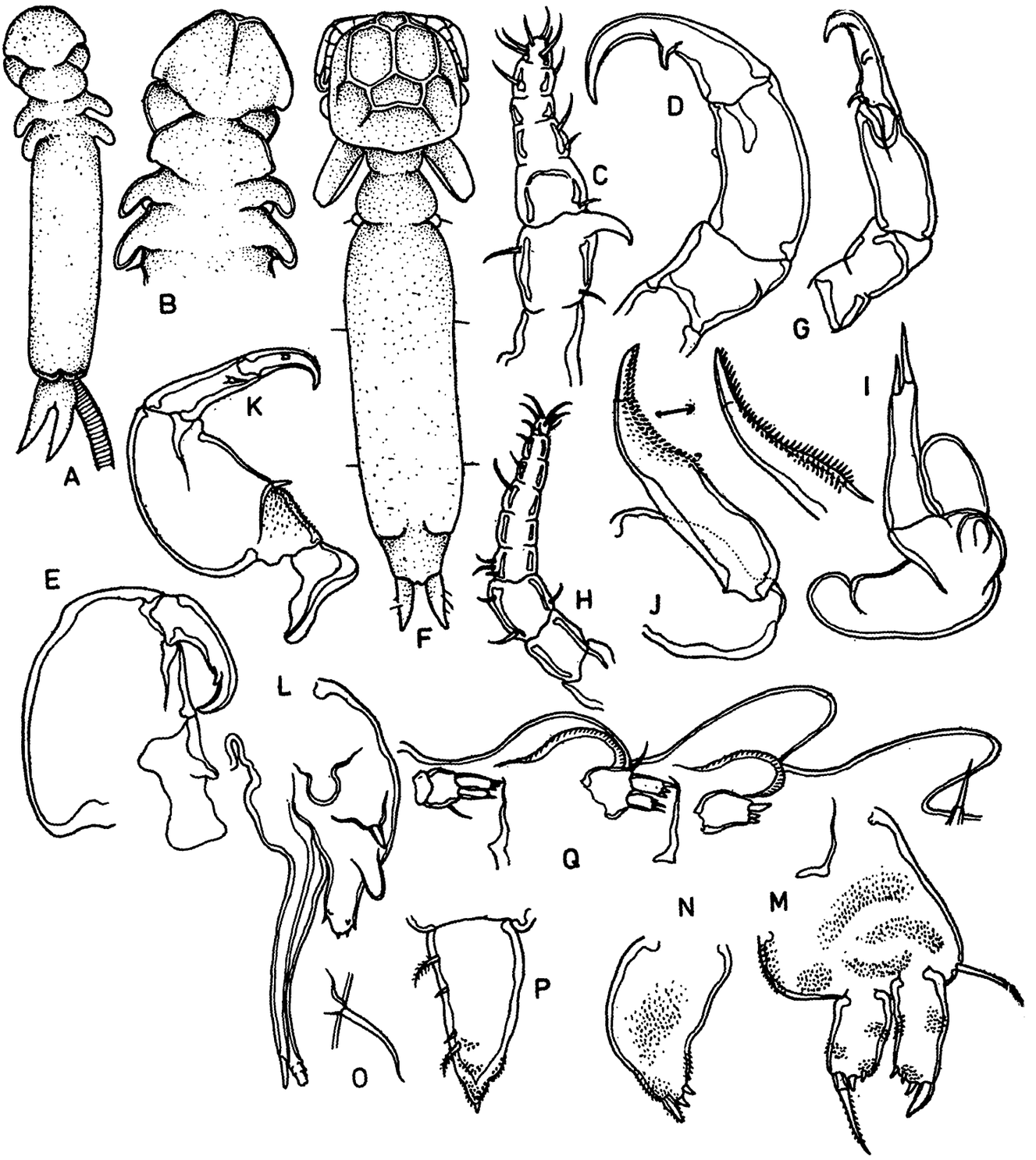


Fig. 245. *Pseudocycnus armatus* (Bassett-Smith) : A-E, Q, Female : A, female, dorsal view ; B, anterior part ; C, antennule ; D, antenna ; E, maxilliped. F-P, Male : F, male, dorsal view ; G, antenna ; H, antennule ; I, maxillule ; J, maxilla ; K, maxilliped ; L, leg 1 ; M, leg 2 ; N, leg 3 ; O, leg 4 ; P, caudal ramus ; Q, ventral view of trunk of female showing legs 1-4.

curved and with a large median process. Maxillule as in *P. appendiculatus*. Distal segment of maxilla distally not expanded, armed with small spines. Basal segment of maxilliped massive, with a pad-like elevation close to its base, distal segment small, distally sharply curved and with an accessory process.

First and second legs biramous, third uniramous, fourth a small tubercle carrying a seta, fifth absent.

*Length.*—5.4 mm.

*Male.*—Cephalothorax circular, broader than trunk, second thoracic segment narrow, third broadening backwards, other segments fused with genital segment to form a cylindrical trunk. Abdomen partially fused with trunk. Caudal rami with spinules and pectinate setae.

Antennule nine-jointed, second segment without process. Antenna very slender, third segment distally well curved, with two processes. Maxillule as in female. Distal segment of maxilla armed with very small spinules. Basal segment of maxilliped stout, distal long and slender, with two processes.

First leg a distinctly bilobed lamina, basipod with long chitinised stylet, other legs as in female. Fifth leg present, like fourth.

*Length.*—2.4 mm.

*Host.*—*Indocybium guttatum*, *Scomberomorus commersoni*, *S. queenslandicus*.

*Distribution.*—Sri Lanka, India, Australia.

*Remarks.*—Superficially *P. armatus* differs so much from *P. appendiculatus* that their inclusion in the same genus would appear unnatural. In *P. appendiculatus* the antennule is short and four-jointed and the second segment lacks a process. But this appendage when cleared in lactic acid shows that it is six-jointed and that the second segment has a process though small. In the male the antennule is clearly six-segmented and the process on the second segment

is indistinct. The distal segment of the maxilla differs slightly in shape and armature. Maxillipeds differ in the absence of a median process on the distal segment in *P. armatus* and in the shape and size of the basal segment. The first leg is clearly biramous in *P. armatus* but in *P. appendiculatus* it has undergone some modifications. This is to be expected since the first segment in *P. appendiculatus* is more fully incorporated into the cephalothorax. However the biramous nature of this leg is clearly evident in the males of both species. It is perhaps significant that the biramous condition is more evident in the male of *P. appendiculatus* than in *P. armatus*. The reverse is true of the females.

The most obvious difference between the two species is the presence of digitiform processes on the third and fourth segments of *P. armatus* and their alleged absence in *P. appendiculatus*. The fourth segment in the latter species has these processes but are partially fused with the trunk. The location of the fourth legs shows this to be so. There is thus no character separating these two species which can be considered as of generic importance.

## Family DICHELESTHIIDAE

*Diagnosis.*—Head fused with first thoracic segment to form a cephalothorax or the first two thoracic segments indicated. Succeeding thoracic segments fused with genital segment to form a large trunk, or genital segment indicated. Abdomen short and one-segmented. Caudal rami with setae. Egg tubes usually short, with few large eggs. Antennule three to eight-jointed. Antenna prehensile, three-jonted. Maxillule bilobed. Maxilla two-jointed and slender, unguis distinct. Maxilliped absent. Legs one and two biramous, rami one or two-jointed and setose. Legs three and four setiform.

Parasites of teleosts.

Type genus.—*Dichelesthium* Hermann.

*Discussion.*—Under this family Yamaguti included *Dichelesthium* Hermann (1804), *Pseudohatschekia* Yamaguti (1939b), *Pseudocongericola* Yu (1933), *Cybicola* Bassett-Smith (1898c),

*Hatschekia* Poche (1902), *Prohatschekia* Nunes-Ruivo (1954) and *Metahatschekia* Yamaguti and Yamasu (1959). *Hatschekia* and *Pseudocongericola* alone have been recorded from Indian waters.

*Key to genera of* DICHELESTHIIDAE

| | |
|---|---|
| 1. Egg tubes with uniseriate large eggs | **Hatschekia** Poche |
| — Egg tubes with multiseriate small eggs | **Pseudocongericola** Yu |

## Genus **Hatschekia** Poche

*Hatschekia* Poche, 1902, p. 16; Wilson, 1913, p. 239 ; 1932, p. 476 ; Barnard, 1955, p. 276 ; Yamaguti, 1963, p. 135 ; Lewis, 1967, p. 15.
*Pseudoclavella* Bassett-Smith, 1898b, p. 91.
*Caetrodes* Wilson, 1906, p. 203.

*Diagnosis.*—Cephalon rounded or transversely oval. Trunk varying in shape, first two thoracic segments generally indicated, others fused with the genital segment to form a swollen trunk. Genital segment sometimes distinct. Abdomen short, one-jointed, often reduced. Caudal rami setose. Egg sacs generally short, eggs large, few in number.

Antennule up to six-jointed. Antenna three-jointed, first segment often fused with cephalon, third claw-like. Maxillule biramous, rami unequal, with one to three spines. Maxilla slender, two-jointed, distal segment generally with a distal spine, unguis distinct usually forked. Legs one and two biramous, rami one or two-segmented, with spine-like setae. Other legs if present setiform.

Male with cephalon separated from trunk by distinct partition. Abdomen distinct, caudal rami well developed. Appendages as in female. Antennule stouter. Maxilla longer. Legs one and two with one-jointed rami.

Parasites of teleosts.

Type species.—*H. hippoglossi* (Kroyer).

*Discussion.*—As pointed out in the introduction one of the cephalic appendages is missing in this genus. The bilobed structure

at the base of the oral cone is undoubtedly the maxillule. Hence the missing appendage is either the maxilla or the maxilliped. The appendage situated behind the maxillule is very much like the maxilla of eudactylinids and hence it is the maxilliped that is missing in this genus. It may also be pointed out that the maxilliped is absent in Lernaeoceridae while the maxilla is present in all copepods.

Generally it is stated that the genital segment is incorporated into the trunk. But in a few species two posterior segments are clearly visible. Either the genital segment is partially free or the abdomen is two-jointed.

*Key to species of* **Hatschekia**

| | | |
|---|---|---|
| 1. | Cephalon much narrower than trunk, latter thin and leaf-like | *foliata* Redkar *et al* |
| — | Cephalon not narrower than trunk, latter thick and not leaf-like | 2 |
| 2. | Posterior part of trunk suddenly narrowed | *caudata* sp. nov. |
| — | Posterior part of trunk not suddenly narrowed | 3 |
| 3. | Cephalon anteriorly very broad, overlapping trunk | *pholas* (Wilson) |
| — | Cephalon anteriorly not very broad, not overlapping trunk | 4 |
| 4. | Trunk subcylindrical | *sphyraeni* Pillai |
| — | Trunk long elliptic | 5 |
| 5. | Trunk twice as long as broad, posterolaterally produced into lobes | *elliptica* Pillai |
| — | Trunk three times as long as broad, posterolaterally not produced into lobes | *ovalis* (Bassett-Smith) |

## **Hatschekia pholas** (Wilson)
(Fig. 246)

*Caetrodes pholas* Wilson, 1906, p. 203, pl. 4, figs. 48-57; Yamaguti, 1963, p. 145, pl. 154, fig. 1 ; Kirtisinghe, 1964, p. 101.
*Hatschekia pholas* Pillai, 1968c, p. 144, figs. 12-25.

*Female.*—Cephalon large, nearly half the total length of body. Anterior border rounded, antero-laterally expanded into rounded wings or lobes making the front faintly trilobed. Hind part of cephalothorax perfectly rounded and overlapping the anterior

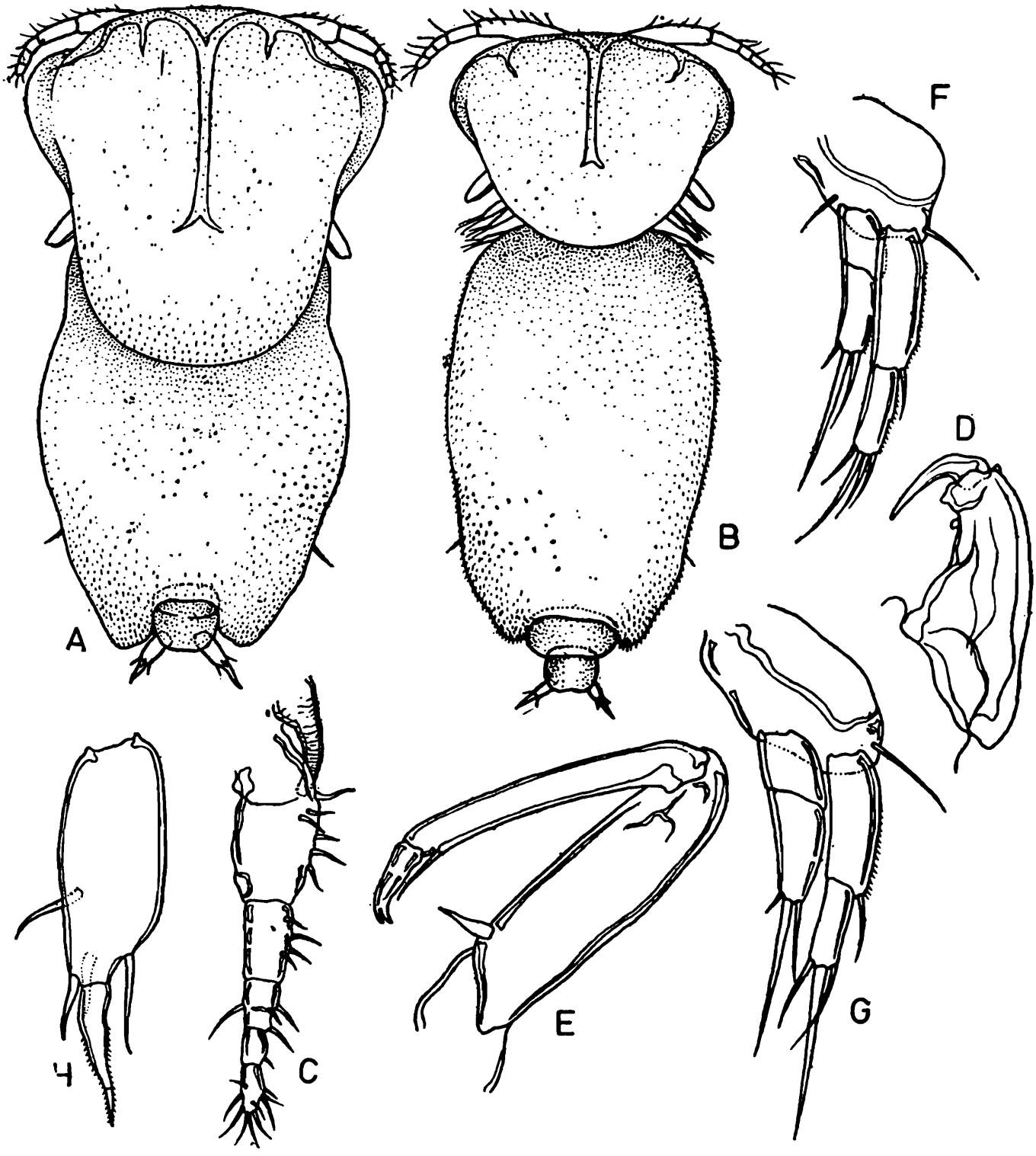


Fig. 246. *Hatschekia pholas* (Wilson) : A, female, dorsal view ; B, same of another female ; C, antennule ; D, antenna ; E, maxilla ; F, leg 1 ; G leg 2 ; H, caudal ramus.

one third of the trunk. Dorsal side of cephalothorax with a T-shaped rib. Trunk oblong, postero-laterally forming rounded lobes embracing abdomen. Genital segment indicated. Abdomen

small and one-jointed. Caudal rami with one stout apical seta and four small setae. Posterior and postero-lateral parts of cephalothorax and lateral and posterior parts of trunk with small spinules. Egg tubes very long, often coiled, eggs large.

Antennule six-jointed, with stiff setae, apical segment with about fourteen setae. Antenna robust, apparently three-jointed, second segment stout and distally produced inwards, third segment a slender claw. Maxillule composed of two rounded lobes, each with two long setae, Basal segment of maxilla with a spine, distal segment slender, with a distal inner spine, as long as basal, unguis distinct, apically forked.

Basipod of first leg with inner and outer seta, rami clearly two-jointed, exopod longer than endopod, its basal segment with one and distal with four setae, distal endopod segment with three setae. Second leg similar to first but larger, basipod with outer seta, inner absent, distal exopod segment with three setae. Third leg represented by a pair of setae on the trunk, other legs absent.

*Length.*—1.4 mm.

*Host.—Tetrodon stellatus, Monotretus cutcutia.*

*Distribution.*—Sri Lanka, India (Kerala).

*Remarks.*—I have compared by specimens with those deposited by Wilson in the United States National Museum. They agree in all essential details. Except for the shape of the body and the size of the cephalothorax *Caetrodes pholas* does not show a single character which distinguishes it from species of *Hatschekia.* The shape of the body is quite variable in this genus.

### **Hatschekia ovalis** (Bassett-Smith)
(Fig. 247)

*Pseudoclavella ovalis* Bassett-Smith, 1898b, p. 95, pl. 6, fig. 1 ; Yamaguti, 1963, p. 171.
*Hatschekia ovalis* Pillai, 1969, p. 171, figs. 131-135.

*Female.*—Cephalothorax roughly squarish, with rounded corners, a median longitudinal rib divides it into two lateral halves.

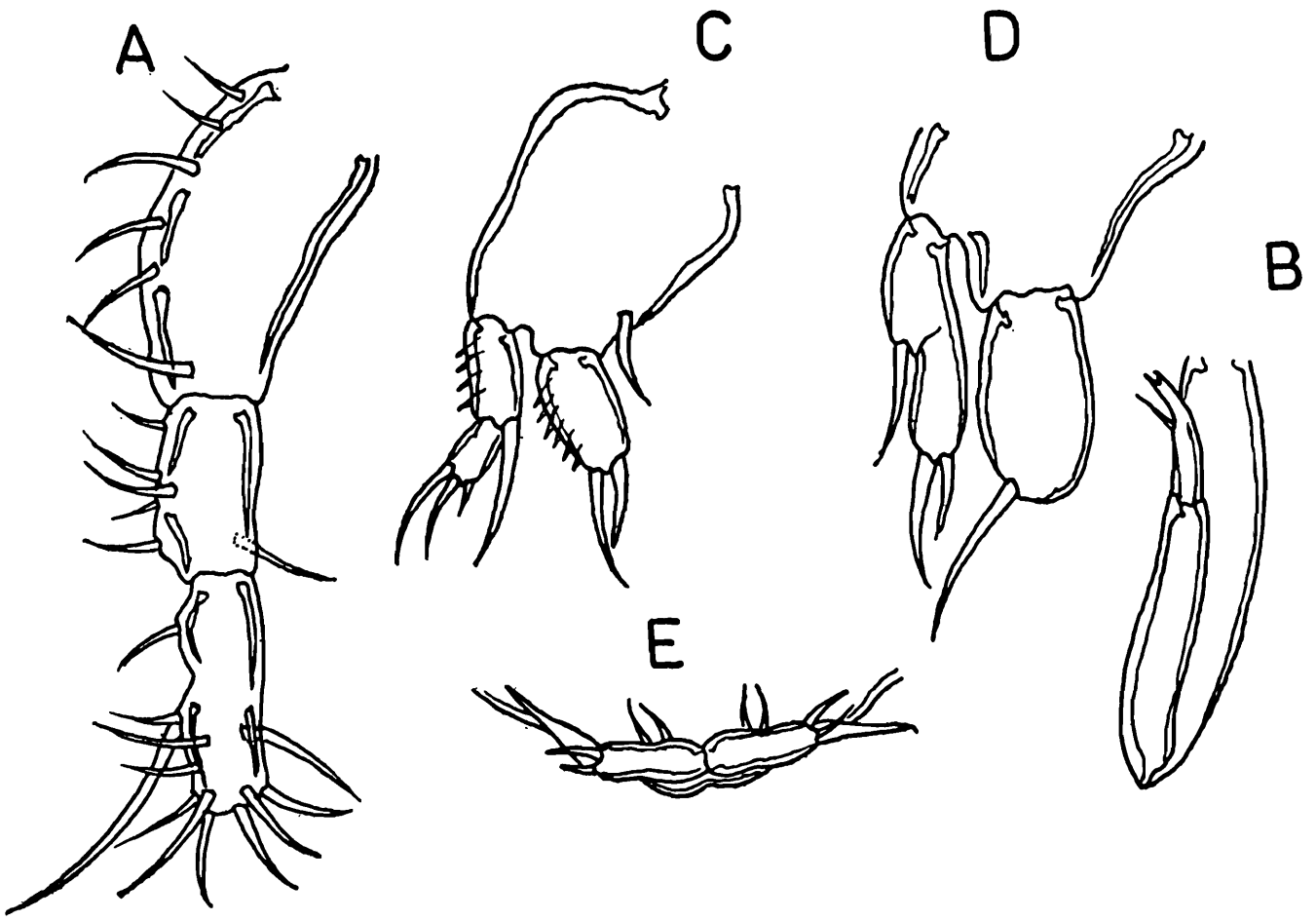


Fig. 247. *Hatschekia ovalis* (Bassett-Smith) : A, antennule ; B, maxilla ; C, leg 1 ; D, leg 2 ; E, caudal rami.

First trunk segment clearly demarcated, other segments fused to form a long elliptic trunk about four times as long as the body in front. Abdomen short, on the ventral side of trunk. Caudal rami twice as long as broad, each with two proximal and three distal setae, median distal seta stout, with swollen base. Egg tubes as long as body.

Antennule three-segmented, basal segment longest and stoutest, second shortest, all segments well setose, third segment with a long seta. Maxilla long and slender, distal segment with distinct unguis carrying a long slender spine, unguis apically forked. Basipod of first leg with inner spine, exopod two-jointed, basal segment twice as long as distal, with one long seta, distal with three setae, endopod one-jointed, with two setae. Second leg longer than first, exopod two-jointed, segmentation incomplete, basal segment with one and

distal with two setae, endopod one-jointed, with one seta. Third and fourth legs setiform, situated at equal distance on the trunk.

*Length.*—3.0 mm.

*Host.*—*Serranus* sp.

*Distribution.*—Gulf of Oman (Muscat).

*Type* in the British Museum (N.H.).

*Remarks.*—This species is a typical member of the genus *Hatschekia* and on reading the description given by Bassett Smith one fails to understand by what character it resembles *Clavella.* More surprising is the fact that Yamaguti recognised *Pseudoclavella* as valid and placed it in the family Pseudocycnidae. The above description based on the type clearly shows that *Pseudoclavella* is a synonym of *Hatschekia.* Unfortunately I could not make a more detailed study of this species.

### **Hatschekia foliata** Redkar, Rangnekar and Murti
(Fig. 248)

*Hatschekia foliata* Redkar *et al.*, 1949, p. 39, figs. 8-14 ; Pillai, 1964b, p. 69, figs. 63-73.

*Female.*—Cephalon very small, transversely rectangular or oblong, laterally rounded, antero-median part produced and bilobed. Dorsal side with prominent ribs. Cephalon fused with trunk, latter long elliptic and leaf-like, without segmentation, getting wrinkled on preservation. Abdomen short. Caudal rami small, attached to dorsal side of abdomen, each with five setae, three of them spine-like, apical seta large. Egg tubes short and slender, with about twenty eggs.

Antennule three-segmented, only slightly projecting beyond cephalothorax, all segments with spine-like setae. Antenna stout, distal segment with swollen base. Maxillule apparently formed of a single lobe carrying two unequal setae. Distal segment of maxilla longer than basal, with inner distal spine, unguis apically forked, basal segment with proximal inner spine.

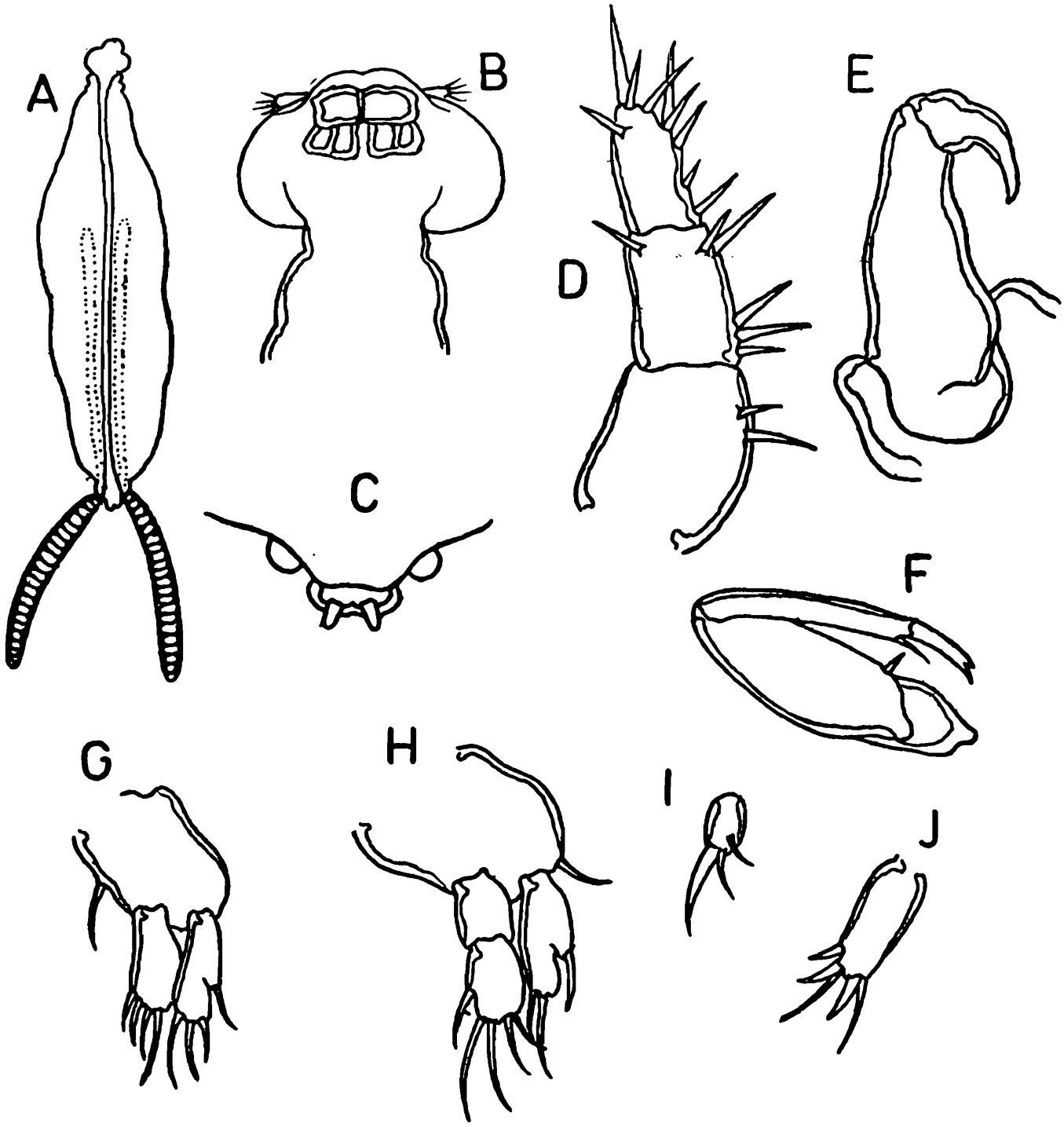


Fig. 248. *Hatschekia foliata* Redkar et al. : A, female, dorsal view ; B, anterior part of body ; C, posterior part of body ; D, antennule ; E, antenna ; F, maxilla ; G, leg 1 ; H, leg 2 ; I maxillule ; J, caudal ramus.

First leg longer than second, rami with imcomplete segmentation. Basipod of first leg with outer seta, basal segment of exopod with one and distal with two setae, endopod longer than exopod, basal segment with one and distal with four setae, endopod longer than exopod. Second leg smaller than first, basipod with one inner seta,

endopod one-segmented, with four apical setae, basal segment of exopod with one and distal with three setae.

*Length.*—2.4 mm.

*Host.—Nemipterus japonicus.*

*Distribution.*—India (Bombay, Kerala).

Location of type not known.

*Remarks.*—This species can be easily identified by the comparatively very small cephalothorax and the long leaf-like trunk. *H. foliata* is very common on *Nemipterus.*

**Hatschekia sphyraeni** Pillai
(Fig. 249)

*Hatschekia sphyraeni* Pillai, 1964b, p. 72, figs. 74-82.

*Female.*—Cephalon broader than long, with rounded sides, antero-medially slightly produced. Dorsal ribs as two contiguous rectangles. Trunk oblong, more than twice as long as broad, first two thoracic segments indicated. Abdomen small. Egg tubes short but broad.

Antennule without segmentation, setae few in number. Antenna stout, distal segment falcate, with long basal inner spine. Maxillule bilobed, each lobe with two setae, those on the outer lobe modified into pectinate spines. Maxilla fairly stout, with the usual armature, unguis not forked but with a subapical process.

First leg smaller than second, basipod with inner spine and outer seta, endopod short and one-segmented, with one seta, exopod two-jointed, basal segment with one and distal with four short setae. Basipod of second leg with outer seta, rami sub-equal in size, endopod one-jointed, with two short setae, basal segment of exopod with one and distal with two setae. Third leg a small lobe carrying three setae.

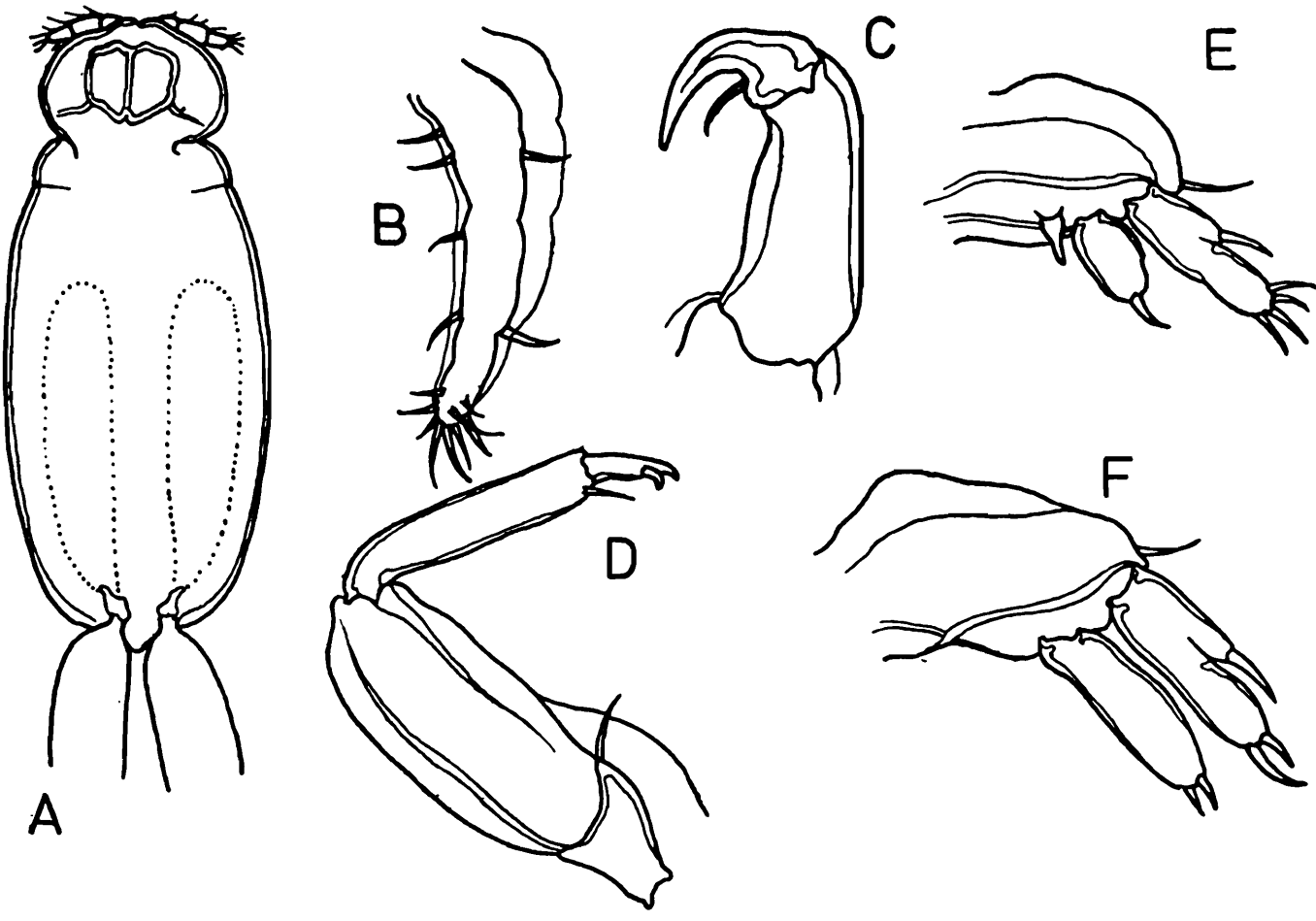


Fig. 249. *Hatschekia sphyraeni* Pillai : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxilla ; E, leg 1 ; F, legs 2.

*Length.*—1.2 mm.

*Host.*—*Sphyraena acutipinnis.*

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta Reg. No. C 2163/2.

*Remarks.*—This is a typical member of the genus but every appendage exhibits some small but very characteristic features.

**Hatschekia elliptica** Pillai
(Fig. 250)

*Hatschekia elliptica* Pillai, 1968c, p. 141, figs. 1-11.

*Female.*—Cephalon transversely elliptic and clearly demarcated from trunk, antero-medially bulged, postero-medially convex

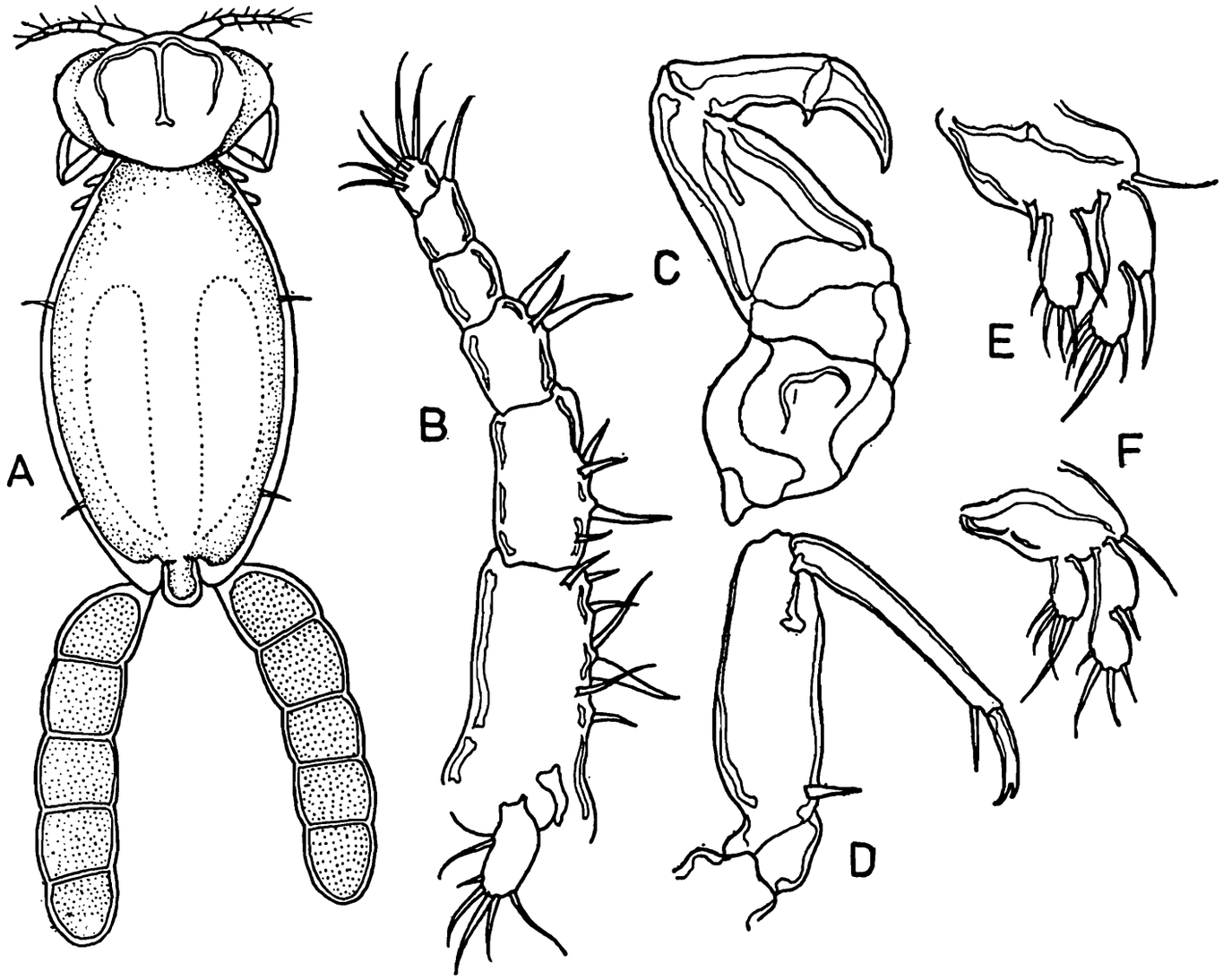


Fig. 250. *Hatschekia elliptica* Pillai : A, female, dorsal view ; B, antennule ; C, antenna ; D, maxilla ; E, leg 1 ; F, leg 2.

and overlapping trunk. Trunk long elliptic, with evenly convex borders. First two thoracic segments indicated by lateral incisions. Postero-lateral parts of trunk produced into rounded lobes reaching the tip of the abdomen. Genital segment indicated. Abdomen small, on the ventral side of genital segment. Caudal rami with one proximal and five distal setae. Egg tubes short but stout, each with five large eggs.

Antennule six-segmented and well setose, first two segments long. Antenna stout and three-jointed, third segment large, with a partition carrying a short process. Maxillule bilobed, each lobe with two spines. Maxilla slender, with the usual armature, distal segment longer than basal.

Basipod of first leg with outer and inner setae, rami indistinctly two-jointed, endopod shorter, basal exopod segment with a stout seta, distal with five setae, basal endopod segment with one and distal with four setae. Basipod of second leg with outer seta, basal exopod segment with one and distal with four short setae, endopod with four setae. Third and fourth legs setiform.

*Length.*—0.7 mm.

*Host.—Diodon hystrix.*

*Distribution.*—India (Kerala)

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta.

**Hatschekia caudata** n.sp.
(Fig. 251)

*Female.*—Cephalon nearly rounded. Anterior part enlarged into a bilobed projection, lateral parts forming another pair of rounded lobes, posteriorly produced over the trunk. Dorsal side of cephalon with prominent ribs. First two trunk segments clearly demarcated, much broader than cephalon, others fused into a long trunk with subparallel sides, behind the fourth legs the trunk is suddenly narrowed producing a tail. Genital segment large, immersed in trunk. Abdomen very short. Caudal rami oblong, with one outer and four distal setae, second distal seta from the inner side basally swollen.

Antennule six-jointed, sparsely setose, sixth segment very small. Antenna slender and three-segmented, basal segment short, second segment long and slender, with transverse grooves, third segment slender and claw-like, its base swollen, claw with blunt serrations. Maxilla slender, distal segment longer than basal, with distal spine, unguis forked.

Basipod of first leg with outer seta and inner spine, exopod longer than endopod, indistinctly two-jointed, basal segment with one and distal with three setae, endopod one-jointed, with two

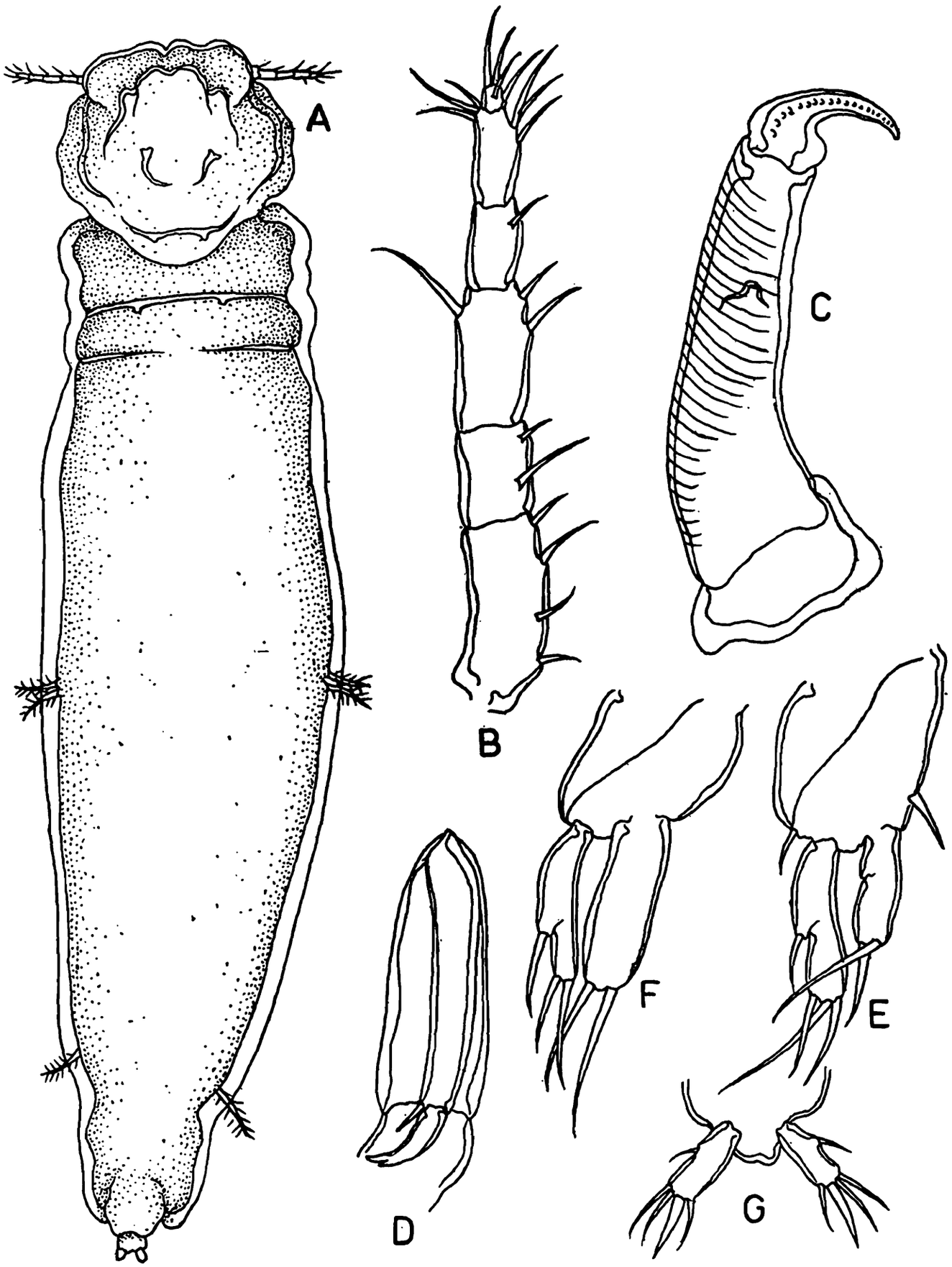


Fig. 251. *Hatschekia caudata* sp. nov. : A, female, dorsal view; B, antennule ; C, antenna ; D, maxilla ; E, leg 1 ; F, leg 2 ; G, caudal rami.

setae. Basipod of second leg unarmed, exopod two-jointed, basal segment with one and distal with two setae, endopod longer and stouter than exopod, with two setae. Third leg represented by a pair of plumose setae and fourth leg by a single plumose seta.

*Length.*—0.9 mm.

*Host.*—*Lutianus* sp.

*Distribution.*—India (Kerala).

*Holotype.*—Female in the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C 2164/2.

*Remarks.*—In the presence of a tail-like constriction at the posterior end *H. caudata* remotely resembles *H. cernae* Goggio (1905). But the former can be distinguished by the shape of the cephalon and the segmentation of the first and second legs.

## Genus **Pseudocongericola** Yu

*Pseudocongericola* Yu, 1933, p. 130 ; Yamaguti, 1963, p. 141.

*Diagnosis.*—Cephalon fused with first thoracic segment, forming a transversely ovate cephalothorax. Second and third thoracic segments clearly indicated by lateral constrictions, but septa absent. Succeeding segments fused with genital segment to form an elongate oblong trunk twice as long as the body in front. Abdomen indicated by a bilobed process. Caudal rami with three apical setae. Egg sacs as long as body, eggs multiseriate.

Antennule three-jointed, with spiniform setae. Antenna short, prehensile, basal segment proximally broad, distal segment basally enlarged, distally claw-like. Maxillule cylindrical, distally bifurcate and with spines. Maxilla generally as in *Hatschekia*, without the usual spines. Legs one and two with two-jointed rami, endopod stouter than exopod, both rami covered with overlapping scales. Third leg a tubercle carrying two short setae. Fourth leg absent.

Parasites of teleosts.

Type species.—*P. chefoonensis* Yu.

### Pseudocongericola chefoonensis Yu

*Pseudocongericola chefoonensis* Yu, 1933, p. 131, pl. 5, figs. 3-4, pl. 6, figs. 1-4 ; Yamaguti, 1939b, p. 473, pl. 28, fig. 138 ; 1963, p. 141 ; Shiino, 1957c, p. 407, fig. 7.

*Host.—Muraenesox cinereus, M. talabonoides.*

*Distribution.*—China, Japan, India (Bombay).

*Remarks.*—This being the only known species the specific characters are the same as those of the genus. Shiino has given a good description of this species.

This species is included here as Redkar *et al.*, have recorded it from Bombay.

## Family Lernaeoceridae

*Diagnosis.*—Body long, cylindrical and usually unsegmented, straight or curved, demarcated into head, neck and trunk, latter usually composed of a genital and an abdominal part. Head with rounded lobes, short processes, branched horns, or with none. Neck rarely faintly segmented, carrying three to five pairs of legs crowded together just behind head or somewhat spaced, processes may be present. Caudal rami small or reduced to setae. Egg tubes straight, coiled or spiral, eggs uniseriate.

Antennule with indistinct segmentation, usually setose, may be reduced or absent. Antenna generally three-segmented and subchelate, may be deformed. Oral aperture at the tip of a protrusible proboscis enclosing two chitinous structures of unknown homology and a pair of mandibles. Maxillules bilobed, with long setae, placed close to base of proboscis, maxillae just behind. Maxillipeds absent. Legs one and two biramous, others uniramous, rami two-jointed and setose, often absent in the adult.

Male represented by the post larva.

*Discussion.*—Sproston *et al*, (1950) transferred *Lernaea* to Cyclopodia. This is correct since *Lernaea* and related genera like

*Therodamas*, *Mugilicola* and *Paeonodes*, unlike lernaeoceriform copepods have egg sacs with multiseriate eggs. The legs are widely distributed on the trunk and the oral appendages are of the biting type. The removal of *Lernaea* to Cyclopoida necessitated the creation of a new family name. Gooding and Humes (1963) suggested the name Lernaeoceridae.

The subdivision of Lernaeoceridae is largely a matter of convenience. Delamare-Deboutteville and Nunes-Ruivo (1955) divided the old family Lernaeidae into Lernaeinae, Lernaeocerinae and Lernaeenicinae. The last two subfamilies with which we are concerned at present differ mainly in the shape of the trunk, straight in Lernaeenicinae and curved in Lernaeocerinae.

Yamaguti (1963) placed *Pennella* along with *Lernaeolophus* in the family Pennellidae, characterised by the presence of abdominal processes. He placed *Peroderma* under Perodermatidae. But this does not seem to have been accepted by recent workers.

Recent studies have revealed that, notwithstanding the diversity in the shape of the body, there is homogenity in the nature of the cephalothoracic appendages. Hence the exact relationship among the genera of the family is difficult to assess.

The homology of the cephalothoracic appendages of lernaeocerids has till recently been very confusing. Hence I am summarising below the consensus of recent opinion. The antennule is digitiform, indistinctly segmented and placed on the dorsal side of the head. According to Kabata (1968) its chaetotaxy may show the relationship within the family. The antenna is three-jointed and chelate, except in *Peniculus* and *Peniculisa* in which it is much deformed. The proboscis encloses a pair of mandibles with or without distal teeth. Antero-medially, within the proboscis, is a chitinised plate (chitinised plaque) and just below this a pair of processes (intra buccal stylets). According to Gooding and Humes (1963) these two structures, which have created all the confusion, are not appendages.

The mandibles and maxillules arise from a common base. The mandibles enter the proboscis but the maxillules remain outside. The latter consists of a large inner lobe carrying two setae and a

small outer lobe with one seta. Posterior to the proboscis is a two or three-jointed appendage which has been designated as maxilliped. But Ho (1966) showed that the maxillipeds do not develop in the females of lernaeocerids. The above pattern is applicable to the entire family though there may be reduction or simplification.

Family Lernaeoceridae includes sixteen genera, of which seven have been recorded from Indian waters. The available descriptions of a majority of the known species are somewhat unsatisfactory. Hence I am unable to provide correct information about most of them.

*Key to genera of* LERNAEOCERIDAE

| | | |
|---|---|---|
| 1. | Abdomen with brush-like out-growths | .2 |
| — | Abdomen without brush-like outgrowths | .3 |
| 2. | Body with a sigmoid curve, head with long branched horns | **Lernaeolophus** Heller |
| — | Body without sigmoid curve, head with short processes | **Pennella** Oken |
| 3. | Head terminal | .4 |
| — | Head subterminal | **Peroderma** Heller |
| 4. | Antenna deformed | .5 |
| — | Antenna not deformed | .6 |
| 5. | Trunk with postero-lateral processes | **Peniculisa** Wilson |
| — | Trunk without postero-lateral processes | **Peniculus** Nordmann |
| 6. | Head with a tuft of finely branched processes forming a hood | **Cardiodectes** Wilson |
| — | Head with two to three branched or unbranched processes not forming a hood | **Lernaeenicus** Le Sueur |

## Genus **Lernaeenicus** Le Sueur

*Lernaeenicus*, Wilson, 1932, p. 480 ; Yamaguti, 1963, p. 185.

*Diagnosis.*—Head with two or more processes projecting outwards or obliquely backwards, simple, nodular or branched. Neck narrow and usually flexed, carrying four pairs of legs placed close together. Trunk enlarged, straight and cylindrical. Abdomen narrow. Caudal rami present or absent. Egg sacs long and slender, eggs strongly flattened. Antennule two to five-jointed. Antenna three-jointed and chelate. Proboscis protrusible, with three chitinous rings. Oral appendages as in family. First two pairs of legs placed

close together, biramous, rarely uniramous, third uniramous, fourth like third, may be absent, fifth absent.

Parasites of elasmobranchs and teleosts.

Type species.—*L. radiatus* (Le Sueur).

*Key to species of* LERNAEENICUS

| | | |
|---|---|---|
| 1. | Cephalon with short stumpy horns | .2 |
| — | Cephalon with long or short, branched or unbranched processes | 7 |
| 2. | Horns two | *anchorellae* Sebastian and George |
| — | Horns three | .3 |
| 3. | Horns apically acute | *polynemi* (Bassett-Smith) |
| — | Horns apically blunt | .4 |
| 4. | All the horns short and knob-like | *longiventris* Wilson |
| — | All the horns elongated | .5 |
| 5. | Thoracic segments indicated by dorsal septa | *stromatei* Gnanamuthu |
| — | Thoracic segments not indicated. | .6 |
| 6. | Horns subsimilar, neck of uniform diameter | *hemirhamphi* Kirtisinghe |
| — | Median horn longer and narrower than lateral, neck narrow in the middle | *sayori* Yamaguti |
| 7. | Cephalic processes in one whorl | .8 |
| — | Cephalic processes in two whorls | .9 |
| 8. | Processes short and stout | *alatus* Rangnekar |
| — | Processes long and slender | *seeri* Kirtisinghe |
| 9. | Anterior processes shorter and stouter than the posterior | *nemipteri* Gnanamuthu |
| — | Anterior processes similar to the posterior | *ramosus* Kirtisinghe |

## **Lernaeenicus hemirhamphi** Kirtisinghe
(Fig. 252)

*Lernaeenicus hemirhamphi* Kirtisinghe, 1933, p. 550, figs. 4-7 ; 1964, p. 169 ; Gnanamuthu, 1953, p. 1, figs. 1-9 ; Heegaard, 1962, p. 185, figs. 207-208 ; Shiino, 1965., p. 435, figs. 1-2.

*Female.*—Body, especially neck and abdomen, long and narrow. Head small, longer than broad, ventrally flat and dorsally arched. Horns three, subsimilar, but the symmetry often lost due to slight branching, posterior horn directed backwards and postero-lateral ones outwards and backwards. Neck very long and tubular, posteriorly widening to join the trunk. Trunk less than half the length of

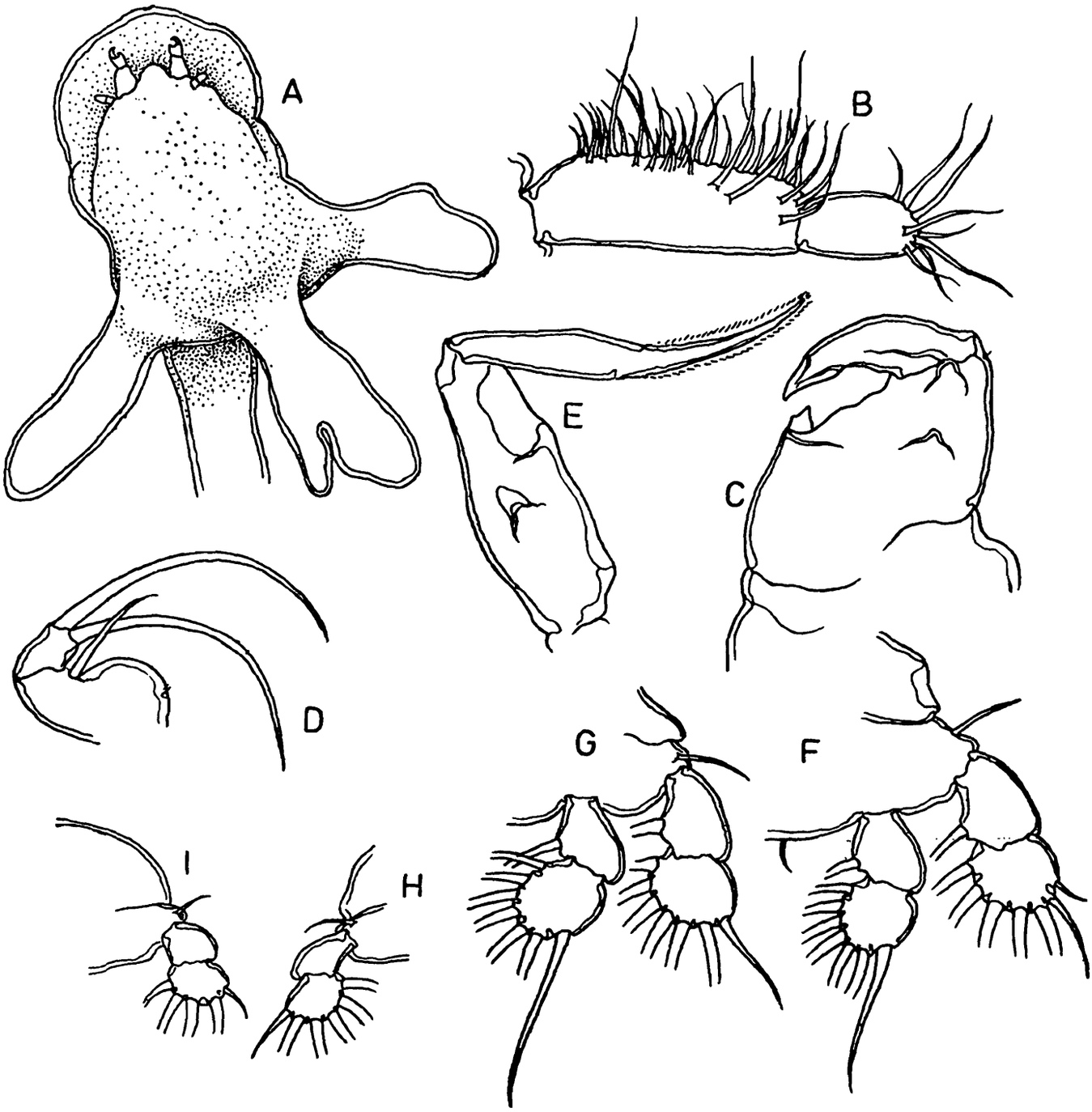


Fig. 252. *Lernaeenicus hemirhamphi* Kirtisinghe : A, adult female, cephalothorax ; B-I, immature female : B, antennule ; C, antenna ; D, maxillule ; E, maxilla ; F-I, leg 1-4.

neck, cylindrical, suddenly constricted to continue as the abdomen. Genital part of trunk forming a step-like projection giving attachment to the egg tubes. Abdomen dorso-ventrally flattened, in lateral view only half as deep as trunk, one and a half times as long as trunk and two-thirds as long as neck. Caudal rami absent. Egg tubes slightly longer than abdomen.

Antennule four-jointed and setose, second segment with a cluster of long setae. Antenna three-jointed and chelate, terminal segment sharp and strongly curved. Oral tube projecting, enclosing the mandibles. Maxillules situated on either side of the proboscis, inner lobe with two long setae, outer lobe obsolete, with one short seta. Maxillae three-jointed, basal segment with two processes, apical segment narrow, as long as second, ventral border of second and third segments denticulated.

Legs four pairs, crowded just behind the head, successively decreasing in size. First leg almost on the head, others on the neck. Legs one and two biramous, others uniramous. Rami of all legs two-jointed and setose.

*Length.*—40-50 mm.

*Host.*—*Hemirhamphus xanthopterus*, *H. intermedius*, *H. far*, *Coryphaena* sp.

*Distribution.*—Sri Lanka, India (Madras, Kerala), Hawaii.

*Remarks.*—In juveniles the antennule is two-jointed and profusely setose. Setae on the inner lobe of the maxillule are very long. The third segment of the maxilla is not distinct from second and has a pectinate flange.

### **Lernaeenicus ramosus** Kirtisinghe
(Fig. 253)

*Lernaeenicus ramosus* Kirtisinghe, 1956, p. 20, figs. 12-14 ; 1964, p. 109 ; Shiino, 1958a, p. 84, figs. 5-7.

*Female.*—Body slightly curved ventralwards, dark brown due to the presence of pigment. Head somewhat cylindrical but the oral surface like an irregular disc remaining at right angles to the long axis of the body. Anterior whorl of processes radiating from the disc, each process dividing near base into two of three branches. There is a pair of ventro-median spherical knobs and a cluster of smaller ones in the centre surrounding the oral aperture. The cluster

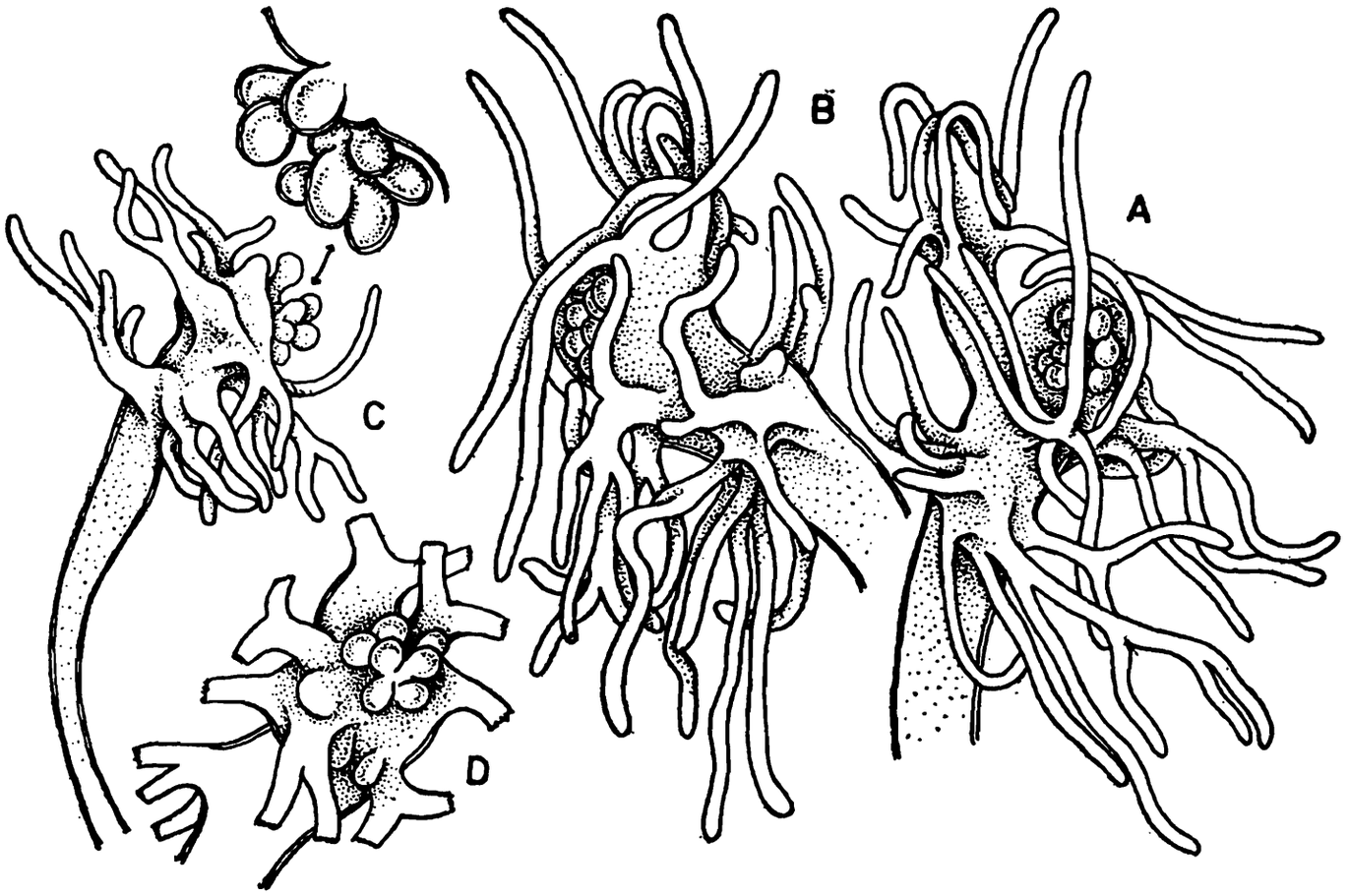


Fig. 253. *Lernaeenicus ramosus* Kirtisinghe : A, cephalothorax, ventral view ; B-C, same, lateral view ; D, oral surface of head.

is actually produced by repeated divisions of two processes. Posterior whorl placed at the hind end of head and composed of three processes, one dorso-median and two lateral, all dividing and remaining parallel to those of the anterior whorl. Neck short, narrower than head, slightly twisted and gradually enlarging to form the trunk. Trunk rather stout and cylindrical, about two-thirds of total length. Egg tubes attached to small semicircular swellings on the ventral side. Abdomen only slightly narrower than trunk, very slightly narrowing backwards and distally rounded or subtruncate. Caudal rami absent. Egg tubes overreaching abdomen.

Legs four pairs, crowded just behind the second whorl of cephalic processes. First two pairs biramous, with two-jointed rami carrying very long setae. Cephalic appendages as usual in the genus.

*Length.*—18-20 mm.

*Host.—Epinepheles morrhua, E. akaara, E. tsirimenaria.*

*Distribution.*—Sri Lanka, India, Japan.

*Remarks.*—Rangnekar (1961) described specimens from *Nemipterus* as *L. ramosus*. But the nature of the cephalic processes indicates that her specimens might belong to *L. nemipteri* Gnanamuthu.

### **Lernaeenicus nemipteri** Gnanamuthu

*Lernaeenicus nemipteri* Gnanamuthu, 1953, p. 2, figs. 9-16.
*Lernaeenicus ramosus* Rangnekar, 1961, p. 196, fig. 2 (nec Kirtisinghe, 1956).

*Female.*—Head somewhat club-shaped, gradually tapering to the beginning of the neck and carrying two whorls of processes, one apical and the other subapical. The apical whorl consists of a few simple and a few branched processes with a dorso-median gap housing two pairs of large swellings flanking the antennae. A pair of stout bifid antero-median processes with smaller ones near their base also present. Subapical whorl more regular and composed of four lateral and two ventral slender processes branched once, each ending in a swelling. Head slightly constricted between the two whorls of processes. Neck comparatively narrow, progressively narrowing and finally widening to join the trunk. Trunk short, as long as neck. Abdomen longer and only slightly narrower than trunk, apex suddently narrowed. Caudal rami represented by setae. Antennule three-jointed. Other appendages as in the genus.

*Length.*—19.6 mm.

*Host.—Nemipterus marginatus, N. japonicus*

*Distribution.*—India (Madras, Bombay, Kerala).

*Remarks.*—Gnanamuthu has described three pairs of appendages within the proboscis, namely mandibles, maxillules and maxillae. As observed earlier the mandibles alone are enclosed within the proboscis. The other two structures described by him are the intrabuccal stylets and the chitinous plaque. He has described the legs as

having one-jointed rami, each with a single curved spine. This is obviously wrong.

*L. nemipteri* closely resembles *L. ramosus* and is distinguished by its abdomen which is longer than the trunk. The reverse is true of *L. ramosus*. The figures of *L. ramosus* included in this work were based on material collected from *Nemipterus*. Perhaps Rangnekar was correct in identifying her material also as *L. ramosus*. A reexamination of the types of *L. nemipteri* alone can decide the validity of this species.

### **Lernaeenicus stromatei** Gnanamuthu

*Lernaeenicus stromatei* Gnanamuthu, 1953, p. 3, figs. 17-22.

*Female.*—Body very long and slender, resembling that of *L. hemirhamphi*. Head attached at right angles to neck, anteriorly rounded and somewhat dorso-ventrally flattened and slightly longer than broad. There are three posterior horns, one median and two lateral, all subsimilar and apically rounded. Anterior part of neck with indistinct partition on dorsal side, indicating thoracic segments. Neck very long, gradually enlarging into the trunk, about three to four times as long as the latter. Abdomen very narrow, about half the length of neck. Caudal rami represented by setae.

Antennule three-jointed, other appendages as in *L. hemirhamphi*. Legs one and two biramous, with two-jointed rami, others uniramous, rami two-jointed and setose.

*Length.*—14.5-63 mm.

*Host.—Parastromateus niger.*

*Distribution.*—India (Madras).

*Remarks.*—This species closely resembles *L. hemirhamphi* but according to Gnanamuthu its head is asymmetrical. But his figures do not show the asymmetry. The presence of incomplete divisions on the neck, if true, will be a useful distinguishing character. A decision regarding the validity of this species is difficult to make since the material including the type is lost.

## **Lernaeenicus sayori** Yamaguti

*Lernaeenicus sayori* Yamaguti, 1939b, p. 479, pl. 31, figs. 174-175, pl. 32, figs. 176-182 ; Rangnekar, 1961, p. 193, fig. 1.

*Female.*—Body comparatively stout. Head slightly longer than broad, somewhat dorso-ventrally flattened and posteriorly produced into three horns, median horn slightly longer and narrower than the lateral. Neck long, narrowing backwards and then widening slightly before joining the trunk. Latter appreciably shorter than neck. Abdomen narrowing, shorter than trunk. Antennule five-jointed and prominently setose, other appendages as in the genus.

*Length.*—34.2 mm.

*Host.*—*Hemirhamphus sajori, Rastrelliger kanagurta.*

*Distribution.*—Japan, India (Bombay).

*Remarks.*—This species orginally discovered in Japan was recorded from Bombay by Rangnekar. Though Rangnekar observed that her specimens resemble the Japanese material her illustrations show otherwise. Yamaguti has shown the neck as narrowing backwards while in Rangnekar's figure it broadens. She has shown the trunk as very stout and the abdomen longer than the trunk. It is definitely shorter in Yamaguti's material. Both descriptions give the old terminology with regard to the appendages.

## **Lernaeenicus alatus** Rangnekar

*Lernaeenicus alatus* Rangnekar, 1961, p. 198, fig. 3.

*Female.*—Head unlike that of any other species, consisting of an anterior small and a posterior large globular portion connected by a median narrow part. Anterior part with a pair of dorso-lateral and a pair of ventro-lateral lobes. Oral surface with two pairs of lobes, anterior ones placed apart from each other and the posterior touching or overlapping. There is also a median lobe just behind the proboscis. Posterior part of head with two pairs of ventro-lateral processes, the lower pair being clearly longer than the upper. Neck narrow, long and gradually merging into the trunk.

Trunk almost of uniform width. Egg tubes attached to short projecting lobes. Abdomen long, one and three-fourths as long as trunk. Caudal rami absent.

*Length.*—54.9 mm.

*Host.*—*Scomberomorus commersoni.*

*Distribution.*—India (Bombay).

*Remarks.*—Rangnekar described the two whorls of processes as belonging to the head and 'thorax' respectively. She also mentioned a 'genital segment'

Rangnekar found close resemblance between this species and *L. seeri* Kirtisinghe. But the latter has long slender cephalic processes disposed in a single whorl on a cylindrical head. The oral surface carries a few low lobes. If Rangnekar's illustrations are correct *L. alatus* will be a unique species. A better description is however desirable.

### **Lernaeenicus longiventris** Wilson

*Lernaeenicus longiventris* Wilson, 1971, p. 66, pl. 7 ; 1932, p. 483, fig. 290 ; Kirtisinghe, 1964, p. 108.

*Female.*—Head small, placed at right angles to the neck, with three short knobs instead of horns, one posterior and the others postero-lateral. Neck very long and slender, narrowing backwards. Trunk comparatively short and cylindrical, about a quarter of the length of the neck, four times as long as broad. Abdomen very narrow, half as long as neck.

*Length.*—50.0 mm.

*Host.*—*Carnax ignobilis, Gnathanodon speciosus, Coryphaena hippurus, Palinurichthys perciformis, Pomatomus saltatrix, Scomberomorus maculatus, Caranx hippos, C. crysos, Pogonias cromis, Mugil cephalus.*

*Distribution.*—Atlantic ocean (Beaufort), Pacific ocean (Woods Hole), Indian ocean (Sri Lanka).

*Remarks.*—This species is included in the Indian fauna on the authority of Kirtisinghe. It has till recently been recorded only from the American waters.

### **Lernaeenicus seeri** Kirtisinghe

*Lernaeenicus seeri* Kirtisinghe, 1934, p. 173, figs. 18-21 ; 1964, p. 109, fig. 152.

*Female.*—Head rectangular or cylindrical, longer than broad, placed at right angles to neck, with four slender dissimilar processes disposed in a circle at the hind part. Oral surface with two pairs of symmetrically placed lobes surrounding the oral aperture. Neck comparatively short. Trunk abruptly widened, shorter than neck and posteriorly with prominent step-like projection giving attachment to the egg tubes. Abdomen very long and slender, having the same diameter as that of neck, more than three times as long as neck. Egg tubes very long, similar to abdomen in length and diameter.

*Length.*—99.0 mm.

*Host.*—*Acanthocybium solandri.*

*Distribution.*—Sri Lanka.

*Remarks.*—The available description of this species is very brief. Kirtisinghe described the "head as wider than long and connected by a slender stalk to the thorax which anteriorly is of the same diameter as the head but widens posteriorly and bears a pair of chitinised horns on each side" This description is not applicable to the figure. Obviously it is this description which made Rangnekar compare *L. alatus* with *L. seeri.*

### **Lernaeenicus polynemi** (Bassett-Smith)

*Lernaeonema polynemi* Bassett-Smith, 1898a, p. 11, pl. 7, fig. 1.

*Female.*—Head triangular, broadly rounded in front and produced posteriorly into three short spically acute horns. Median horn

directed backwards and the lateral ones slightly outwards and backwards. Neck comparatively very long, narrow in the middle and fairly broad behind the head, posteriorly gradually widening into the trunk which is remotely club-shaped. Abdomen short and narrow, nearly as long as trunk, narrower than neck. Egg tubes long, as broad as abdomen.

*Length.*—70.0 mm.

*Host.—Polynemus tetradactylum.*

*Distribution.*—India (Bombay).

*Remarks.*—The only description of this species so far available is the original one which is far from adequate.

### **Lernaeenicus anchoviellae** Sebastian and George

*Lernaeenicus anchovielae* Sebastian and George, 1964, p. 235, figs. 1-11.

*Female.*—Head comparatively swollen, anteriorly bluntly rounded, dorsally convex, ventrally flat and posteriorly produced into a pair of backwardly directed apically rounded stout but short horns. Neck very long, narrowing backwards. Trunk short, only moderately stout, about a third of the length of the neck. Abdomen suddenly narrowed, narrowing backwards, as long as trunk.

Antennule five-jointed, apical setae very long. Antenna stout and subchelate. Maxilla three-jointed, first two segments with prominences, third slender. Legs as usual in the genus.

*Length.*—25-57 mm.

*Host.—Anchoviella bataviensis.*

*Distribution.*—Indian Ocean (Palk Bay).

*Remarks.*—The absence of a postero-median process on the head and the presence of a long curved neck distinguish this species. The shape of the cephalic horns is very characteristic.

## Genus **Cardiodectes** Wilson

*Cardiodectes* Wilson, 1917, p. 50 ; Yamaguti, 1963, p. 188.

*Diagnosis.*—Head elliptic, anteriorly covered by a hood formed of dichotomously branched processes formed by repeated branching of a pair of processes, the branches forming a loose or compact mass. Neck about a third of the diameter of the trunk, with a pronounced curve. Trunk straight and cylindrical, about twice as long as rest of body. Abdomen short or absent, with or without caudal rami. Egg tubes long and straight.

Antennule two-jointed. Antenna three-jointed and chelate. Mandible small, with or without teeth. Maxillule with two apical setae and a small tubercle carrying a setule. Maxilla three-jointed. Maxilliped absent. Legs one and two placed close together, biramous, third uniramous, placed away from second, fourth, if present, without rami.

Parasites of teleosts.

Type species.—*C. medusaeus* (Wilson).

*Key to species of* **Cardiodectes**

| | |
|---|---|
| 1. Cephalic processes forming a compact bunch, abdomen absent | *krishnai* Sebastian |
| — Cephalic processes forming a loose bunch, abdomen present | *anchorellae* Brian and Gray |

## **Cardiodectes anchorellae** Brian and Gray

*Cardiodectes anchorellae* Brian and Gray, 1928, p.1, pls. 2-5 ; Gnanamuthu, 1951b, p. 237, figs. 1-12 ; Kirtisinghe, 1964, p. 105, fig. 146.
*Cardiodectes medusaeus* ; Kirtisinghe, 1950, p. 84, figs. 36-39 (nec Wilson 1917).

*Female.*—Head roughly rectangular, antero-laterally prolonged into two short processes branching repeatedly to produce two elongated masses of lobes projecting far in front of the head, the whole forming a very loosely massed cap. On the dorsal side of the head are two pairs of large lobes. Neck very short, curving

downwards and then upwards to join the head. Trunk stout, more than twice as long as rest of the body, long-elliptic in shape. abdomen a very short semicircular lobe with faint postero-median incision. What appears to be vestigial caudal rami are present.

*Length.*—4.9-6.4 mm.

*Host.—Stolephorus tri, Thrissocles hamiltoni.*

*Distribution.*—India (Madras, Kerala), Sri Lanka.

*Remarks.*—The description given by Kirtisinghe clearly applies to my specimen but that given by Gnanamuthu is slightly different. The description of the cephalic appendages by Gnanamuthu should be modified in the light of the more recent interpretation. Gnanamuthu described a stumpy three-jointed fourth leg. This needs confirmation since the fourth leg when present is said to lack rami in this genus.

### **Cardiodectes krishnai** Sebastian

*Cardiodectes krishnai* Sebastian, 1968, p. 136, figs. 1-11.

*Female.*—Body curved like a straightened S. Head elongated and narrowing backwards, demarcated from neck by a constriction. Cephalic processes composed of an anterodorsal compact mass of short irregularly branched fleshy processes and a pair of antero-lateral large lobes. Trunk cylindrical, one and a half times the length of the body in front. Abdomen absent.

Antennule apparently three-jointed, with very long setae. Antenna stout, process on second segment small, third segment strongly curved. Maxillule terminating in two long setae. Maxilla as in the genus. Legs one and two biramous, third uniramous, fourth absent.

Length not given.

*Host.—Vinciguerria lucetia.*

*Distribution.*—Arabian Sea.

## Genus **Peniculus** Nordmann

*Peniculus*, Shiino 1956a, p. 593 ; Yamaguti, 1963, p. 201 ; Lewis, 1964a, p. 232.

*Diagnosis.*—Head without processes. Neck narrow, composed of thoracic segments two and three, fourth segment swollen, partially fused with trunk, cephalic and thoracic portions strengthened by chitinous structures. Trunk swollen. Abdomen short, conical and bilobed. Caudal rami setose. Antennule degenerated or absent. Antenna converted into flat lobes in the adult. Other cephalic appendages as in the family. Legs four pairs, situated wide apart.

Type species.—*P. fistula* Nordmann

*Discussion.*—To date five species have been recorded from Indian waters, all by Gnanamuthu. They are distinguished mainly by the shape and comparative size of the different parts of the body which, as pointed out by Lewis, are variable. Hence it is difficult to provide a key for the Indian species. A summary of the specific characters of each species is given below.

### **Pemiculus trichiuri** Gnanamuthu
(Fig. 254 A-B)

*Peniculus trichiuri* Gnanamuthu, 1951a, p. 77, figs. 1-11.

*Female.*—Cephalothorax nearly rectangular, dorsally convex and ventrally concave. Antero-lateral parts produced into rounded lobes. Posterior part of ventral side swollen and projecting, according to Gnanamuthu accommodated in a depression on the body of the host. Neck short, as long as cephalothorax, gradually narrowing backwards. Fifth segment enlarged and separated from trunk by a septum. Trunk gradually widening backwards. Abdomen a small bilobed projection carrying two bunches of setae representing caudal rami.

Antennule composed of three foliaceous parts ?, antenna formed of two parts ?, maxillule a two-jointed appendage with two apical spines. Maxilla stout and three-jointed. Legs biramous ?, first placed just below the ventral swelling on the head, a three-jointed

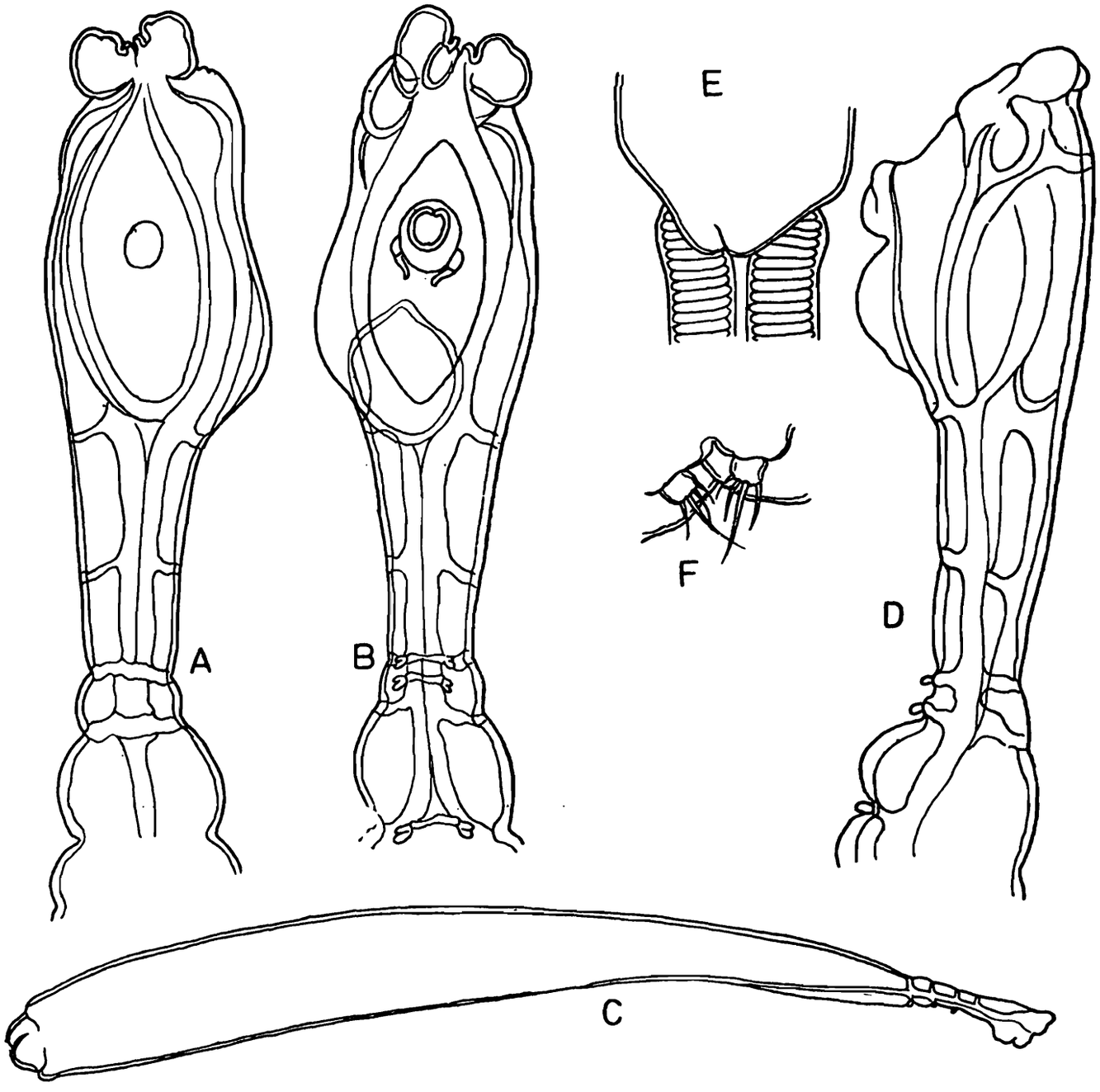


Fig. 254. *Peniculus trichiuri* Gnanamuthu : A, female, cephalothorax, dorsal view ; B, same, ventral view. C-F, *Peniculus sciaeni* Gnanamuthu ; C, female, lateral view ; D, cephalothorax, lateral view ; E, abdomen ; F, caudal rami.

foliaceous structure with four spines ? Legs two to four in young specimens biramous, rami two-jointed and setose.

*Length.*—10-11.8 mm.

*Host.—Trichiurus haumela, T savala, T muticus.*

*Distribution.*—India (Madras).

*Remarks.*—The description of the antennule, antenna and the first leg is obviously wrong. In *Peniculus* the antennule is much reduced and the antenna gets altered in shape due to partial fusion with the body of the host. What Gnanamuthu described as the antero-lateral lobes of the head must be the antennae. The illustration of the first leg is wrong.

### **Peniculus theraponi** Gnanamuthu

*Peniculus theraponi* Gnanamuthu, 1951a, p. 80, figs. 12-23.

*Female.*—Cephalothorax cylindrical, ventro-median part swollen and projecting, carrying the comparatively inconspicuous oral cone. Chitinous bars similar to those of *P. trichiuri.* Neck very short, fourth trunk segment abruptly enlarged, trunk very long and rather deep, about five times as long as the body in front. Abdomen very small, bilobed. Caudal rami represented by four setae, one of them very long.

Antennule and antenna similar to those of *P. trichiuri.* Maxillule two-jointed, terminal segment dactyliform. First leg three-jointed, with two spines ? Second and third legs biramous, fourth uniramous.

*Length.*—10.4 mm.

*Host.—Therapon jarbua.*

*Distribution.*—India (Madras).

### **Peniculus sciaeni** Gnanamuthu
(Figs. 254 C-F)

*Peniculus sciaenae* Gnanamuthu, 1951a, p. 82, figs. 24-29.

*Female.*—Cephalothorax cylindrical, with very large oral cone and equally large ventral swelling just behind. Neck and trunk almost similar to those of *P. theraponi.*

Antennule large ?, flat, covering bases of antennae dorsally and laterally. Antennae club-shaped, with a claw and a median notch. Maxillule with four apical spines ? Segments one and two of maxilla with a spine, third with a claw.

*Length.*—11.7 mm.

*Host.—Sciaena albida.*

*Distribution.*—India (Madras).

*Remarks.*—The description of the cephalic appendages, especially of the antennules and antennae is inaccurate. The above described three species, according to Gnanamuthu, differ in the size of the trunk and the shape of the head.

### **Peniculus stromatei** Gnanamuthu

*Peniculus stromatei* Gnanamuthu, 1951d, p. 221, fig 1.

*Female.*—Head roughly cylindrical, with large ventral prominence. Head followed by four free thoracic segments, first three about half the width of the head. Fourth segment suddenly enlarged, as broad as head. Third segment shortest. Chitinous frame similar to that of *P. theraponi* Gnanamuthu. Trunk nearly three times as broad as head, gradually widening backwards and ending in a bilobed abdominal projection. Caudal rami represented by setae.

*Length.*—9.3 mm.

*Host.—Stromateus niger.*

*Distribution.*—India (Madras).

*Remarks.*—Gnanamuthu defined this species thus :—"Trunk eight times longer than wide, fourth thoracic segment one third as wide as trunk, proboscis inconspicuous, the cephalothorax marked by prominent posterior ventral swelling, head and neck one sixth the length of the trunk and head three fourths the length

of the neck. Abdomen is a short stout swelling and the egg strings are thin"

### **Peniculus scomberi** Gnanamuthu

*Peniculus scomberi* Gnanamuthu, 1951d, p. 224, fig. 2.

*Female.*—Head pyriform, broader behind, ventral side anteriorly concave and posteriorly convex and projecting but less so than in *P. stromatei.* Thoracic segments one to three of the same width making the neck cylindrical, fourth expanded. Neck longer than head. Trunk widens quickly backwards. Abdomen a slight prominence. Caudal rami represented by three pairs of setae.

*Length.*—11 mm.

*Host.—Scomber microlepidotus*

*Distribution*—India (Madras).

*Remarks.*—Gnanamuthu defined this species thus :—"The trunk is six and a half times longer than broad. It is five times broader than the fourth segment, the cephalothorax is uniformly swollen behind, slightly twisted and asymmetrical. The proboscis is conspicuous"

A close study of the descriptions of the five species shows that Gnanamuthu has repeated in each case the generic characters and failed to give the specific characters. He distinguished them by the comparative length of the head, neck and trunk which is not reliable in specific identification.

## Genus **Peniculisa** Wilson

*Peniculisa* Shiino, 1956a, p. 599 ; Yamaguti, 1963 p. 203 ; Izawa, 1965, p. 365 ; Radhakrishnan, 1977, p. 253 ;

*Diagnosis.*——Cephalothorax longer than broad, anteromedially acuminate. Thoracic segments two and three distinct, forming a narrow neck, fourth segment dorsally overlapped by the trunk, clearly indicated ventrally. Trunk formed by the fusion of fifth

and genital segments, much broader than neck, dorso-ventrally flattened and postero-laterally produced into two long processes. Abdomen short, one-jointed, broader than long, fused with trunk. Caudal rami distinct, setose. Antennae slightly modified, other apendages as in *Peniculus*.

Parasites of teleosts.

Type species.—*P. furcata* (Kroyer).

*Discussion.*—The genus now contains four species, *P. furcata* (Kroyer), *P. bicaudata* Shiino, *P. shiinoi* Izawa and *P. wilsoni* Radhakrishnan. It is possible that the last three species are synonymous.

*Key to species of* **Peniculisa**

| | | |
|---|---|---|
| 1. | Trunk processes longer than trunk, egg tubes shorter than trunk processes | *furcata* (Kroyer) |
| — | Trunk processes as long as or shorter than trunk, egg tubes longer than trunk processes | .2 |
| 2. | Trunk processes shorter than trunk | *bicaudata* Shiino |
| — | Trunk processes longer than trunk | .3 |
| 3. | Trunk processes parallel | *shiinoi* Izawa |
| | Trunk processes diverging | *wilsoni* Radhkrishnan |

## Peniculisa furcata (Kroyer)

*Peniculus furcatus* Kroyer, 1963, p. 207, pl. 14, fig. 8.
*Peniculisa furcata* Wilson, 1906, p. 206, pl. 5, figs. 61-66 ; 1917, p. 45; Yamaguti, 1963, p. 203, pl. 224, fig. 3 ; Kirtisinghe, 1964, p. 106.

*Female.*—Cephalothorax elliptical, second and third thoracic segments free, fourth, fifth and genital segments united into a large trunk, antero-laterally shoulder-like and postero-laterally produced into stout long processes subequal to the body in length and prominently diverging. Abdomen short and one-segmented, fused with trunk and postero-laterally produced into prominent rounded lobes overreaching the caudal rami. Caudal rami small but distinct, each with three setae. Egg tubes short, slightly more than half as long as the trunk processes.

Antennules reduced to knobs. Basal segments of antennae fused, apically enlarged into a double disc, claws burried into the host. Oral appendages, except the maxillae reduced. Legs rudimentary, four pairs, one to three placed close together, fourth farther back on the trunk. Each leg composed of a large basipod and two minute knob-like rami.

*Length.*—2.35 mm.

*Host.*—*Holocanthus* sp., *Tetrodon* sp., *Ostracion punctatus*, *Diodon hystrix*.

*Distribution.*—India (Kerala), Sri Lanka, Indonesia.

*Remarks.*—The above description taken from Wilson needs clarification. The antennae do not enlarge into a double disc. The skeletal and connective tissue of the host envelop the tips of the antennae producing two contiguous tumours. The mouth parts cannot be reduced as supposed by Wilson. What Wilson described as knob-like rami on the legs are only projections of the basipod. The rami are lost in the adult.

Because of obvious differences Izawa suggested that the specimens recorded by Kroyer, Wilson and Leigh-Sharpe might not belong to the same species. But one has to concede a certain degree of intraspecific variations as in *P. wilsoni*.

### **Peniculisa wilsoni** Radhakrishnan
(Fig. 255)

*Peniculisa wilsoni* Radhakrishnan, 1977, p. 251, figs. 1-4.

*Female.*—Cephalothorax comparatively narrow, twice as long as broad, antero-medially angular, postero-laterally lobe-like and medially bulging. Second trunk segment much broader and longer than third, fourth ventrally demarcated but dorsally fused with trunk. Trunk large, anteriorly constricted and overlapping third thoracic segment, gradually widening to the base of the trunk processes, latter fairly stout but shorter than trunk and clearly

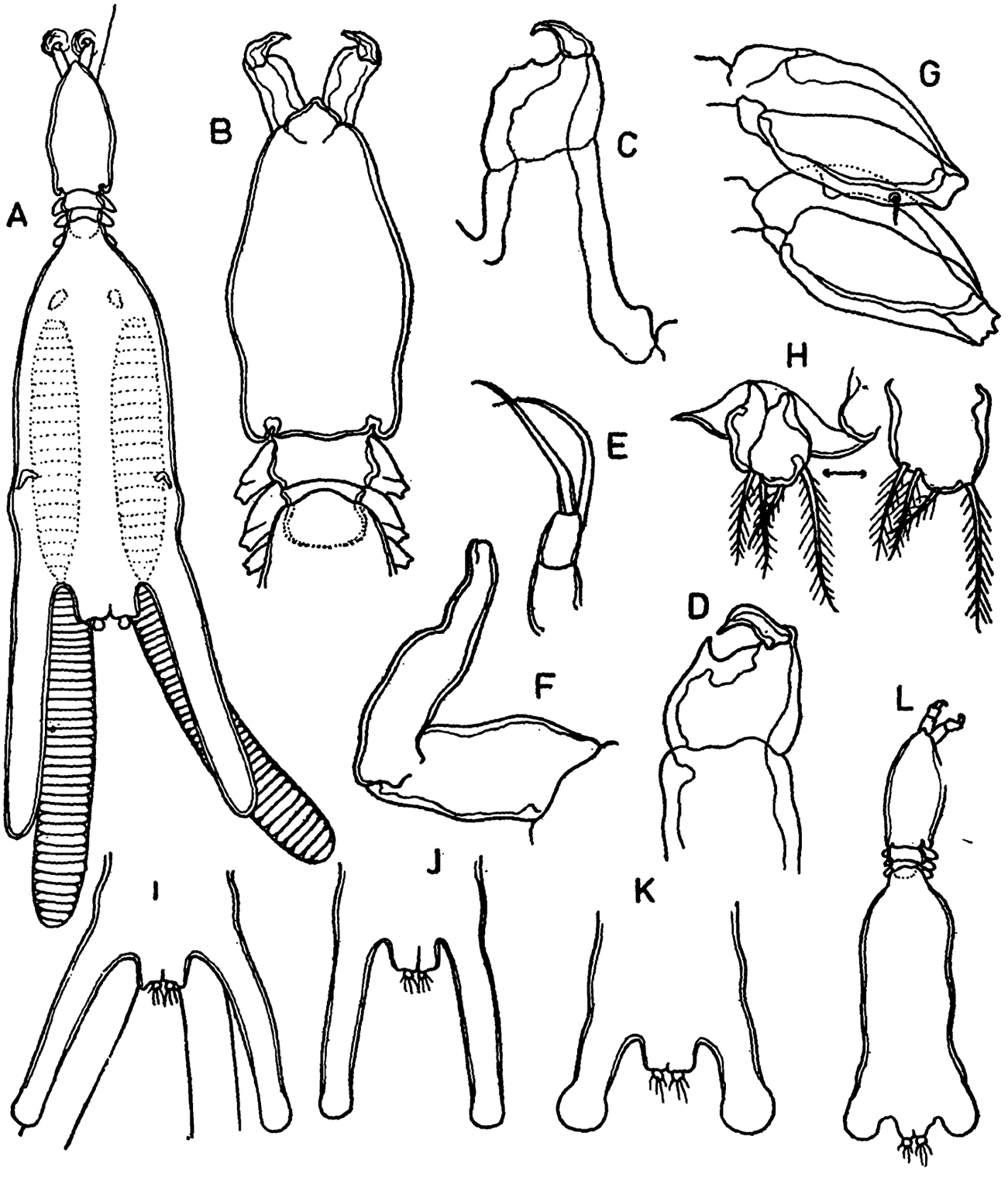


Fig. 255. *Peniculisa wilsoni* Radhakrishnan : A, female, dorsal view ; B, same, cephalothorax ; C, antenna ; D, same of immature female ; E, maxillule ; F, maxilla : G, legs 1-2 ; H, caudal ramus ; I-L, stages in the development of abdomen and trunk processes.

diverging. Abdomen fused with trunk, broader than long, distally bilobed and postero-laterally produced into rounded lobes. Caudal rami with four plumose setae.

Antennule apparently absent. Antenna indistinctly three-jointed, second segment without inner process, third segment short (in juveniles the typical shape is evident). Mandible not observed. Maxillule two-jointed, with two long setae. Maxilla two-jointed, distal segment irregular and apically blunt. Legs one and two placed close together, third slightly away from second and fourth far removed, on the trunk, all legs devoid of rami.

*Length.*—2.75 mm.

*Host.*—*Diodon hystrix.*

*Distribution.*—India (Kerala).

*Remarks.*—In some of the more important characters this species shows variation. This should be taken into consideration while deciding about the validity of *P. bicaudata*, *P. shiinoi* and *P. wilsoni*. These three species are closely related.

## Genus **Lernaeolophus** Heller

*Lernaeolophus*, Yamaguti, 1963, p. 209 ; Kabata, 1968c, p. 103.

*Diagnosis.*—Head somewhat globular, placed more or less at right angles to neck, facing ventralwards. Oral surface with rounded lobes, postero-dorsal part with median and two lateral stout branched processes. Neck very long, often curved. Trunk enlarged, with sigmoid curve, abdominal part with two rows of ventro-lateral branched or unbranched processes. Caudal rami absent. Egg tubes slender, loosely coiled.

Cephalic appendages as in family. Legs four pairs, crowded on the neck, represented by basipods only.

Parasites of teleosts.

Type species.—*L. sultanus* (Nordmann).

*Discussion.*—Following earlier workers Yamaguti described the oral appendages of *Lernaeolophus* as mere buds. But Kabata has shown that *Lernaeolophus* has all the appendages characteristic of other lernaeocerids. It may however be pointed out that Kabata (1968C) designated the appendage behind the oral tube as maxilliped instead of maxilla.

## **Lernaeolophus sultanus** (Nordmann)
(Fig. 256)

*Pennella sultana* Nordmann, 1864, p. 485, figs. 12-16 ; Milne Edwards, 1840, p. 523.

*Lernaeolophus sultanus* Heller, 1868, p. 251, pl. 25, fig. 7 ; Wilson, 1917, p. 91, pl. 13 ; 1932, p. 487, fig. 293 ; Kirtisinghe, 1935, p. 334. fig. 9; 1964, p. 113, fig. 114 ; Heegaard, 1962, p. 185, fig. 209 ; Kabata, 1968c, p. 103, figs. 1-2 ; Raibaut and Ktari, 1971, p. 59, figs. 1-4.

*Female.*—Head circular in outline, disc-like, dorsally convex and ventrally concave. Dorsal side with two lateral and one median horn originating more or less in the middle, all dichotomously branched, though the branching is somewhat irregular. Median horn smaller. Oral surface with an outer circle of three pairs of large tubercles and an inner circlet of three smaller tubercles. Head antero-medially bilobed due to the presence of a longitudinal groove. Neck curved, nearly as long as trunk, latter swollen, curved in the shape of an elongated S, genital part shorter than the abdominal, the two demarcated by a bent similar to the one demarcating the neck from the trunk. Abdomen with eight pairs of dichotomously branched processes, maximum branching observed is four.

Antennule three to four-jointed and setose. Antenna three-jointed and chelate. Mouth tube enclosing a pair of intrabuccal stylets, each tipped with two setae and a pair of nondentate small mandibles. Maxillule composed of a large inner lobe carrying two setae and a small outer tubercle carrying a setule. Maxillule as usual, just behind the mouth tube. Four pairs of legs represented by their basipods, successively decreasing in size and placed at irregular intervals.

*Length.*—23.0 mm.

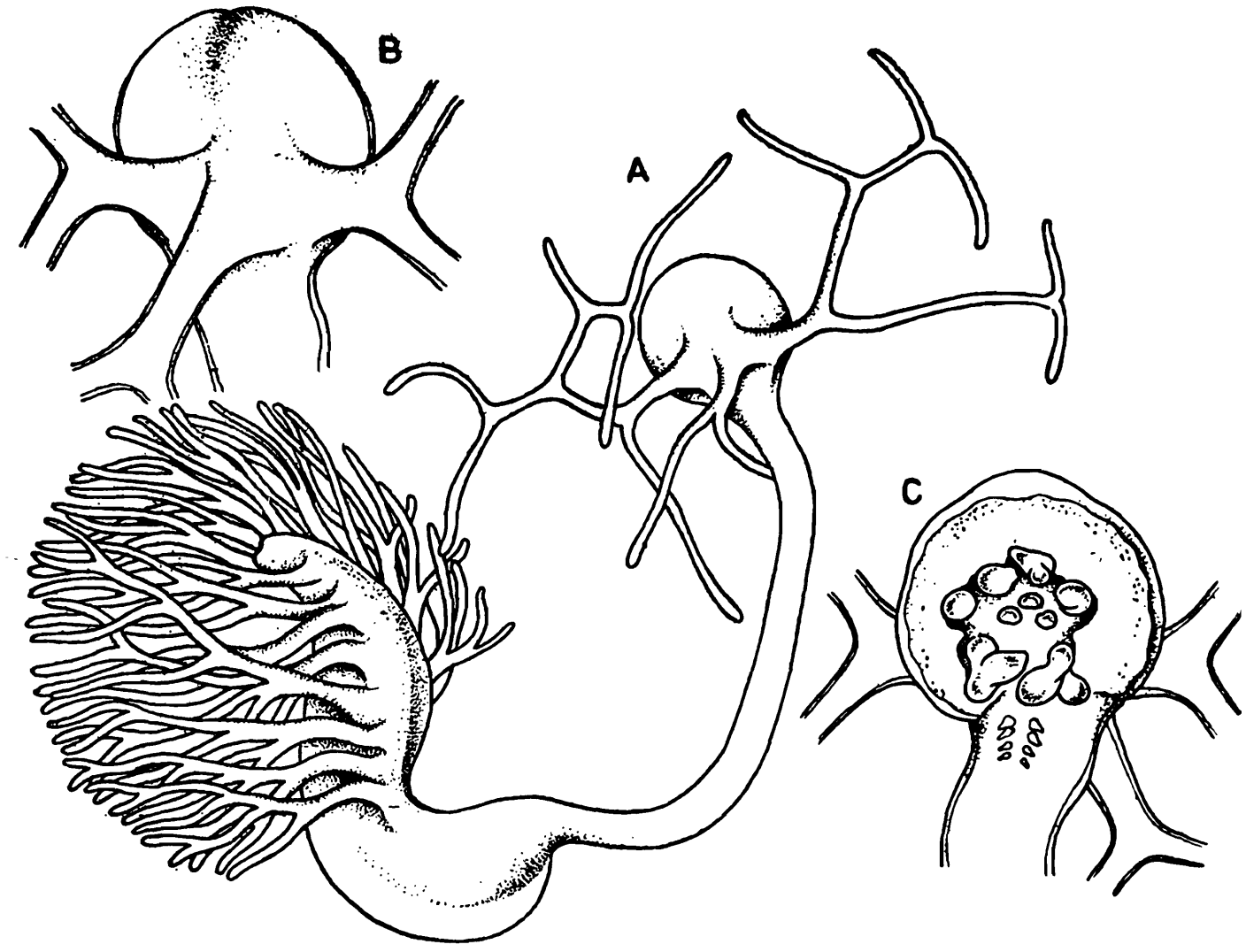


Fig. 256. *Lernaeolophus sultanus* (Nordmann) : A, entire animal ; B, cephalothorax, dorsal view ; C, same, ventral view.

*Host.*—*Serranus cabrilla*, *S. scriba*, *Maena valgaris*, *Haemulon plumieri*, *Istiophorus gladius*, *Alutera shoepfi*, *Tylosurus marinus*, *Diplodus annularis*, *Mugil cephalus*, *Lithognathus mormyrus*, *Acanthocybium solandri*, *Priacanthus hamrur*.

*Distribution.*—Adriatic, Mediterranean, Florida, Woods Hole, Indian ocean (Sri Lanka, Kerala).

*Remarks.*—The description of the general shape of the animal is based on a single specimen I have and that of the cephalic appendages is after Kabata. Though the parasite has been recorded several times the only good illustration available is that by Raibaut and Ktari (1970). As they seem to have illustrated an immature specimen I give below a figure of the entire animal. As observed

by Kabata the shape of the animal varies. In the light of this observation it is possible that *L. recurvus* Wilson (1913) is the same as *L. sultanus*.

## Genus **Pennella** Oken

*Pennella* ; Wilson, 1917, p. 105 ; Barnard, 1955, p. 280 ; Yamaguti, 1963, p. 206 ; Lewis, 1967, p. 20.

*Diagnosis*.—Head in line with the neck. Oral area surrounded by papillae, posterior part of head carrying two to three sclerotised horns directed outwards and rarely backwards. Neck cylindrical, narrower than adjacent portions, continued imperceptibly into the trunk. Trunk enlarged, slightly flattened dorso-ventrally, with pregenital projection giving attachment to egg tubes. Abdomen tapering, with two ventro-lateral rows of long branched or unbranched processes. Egg tubes very long.

Antennule three to four-jointed. Antenna three-jointed and chelate. Oral appendages much reduced ? Legs four pairs, first two close together, others wide apart, first and second biramous, others uniramous.

Parasites of teleosts, rarely of mammals.

Type species.—*P. sagitta* (Linn.).

*Discussion*.—In the descriptions of species of *Pennella* there is practically no mention of the oral appendages. Both Yamaguti and Lewis stated that in the adult the oral appendages are reduced or absent. *Pennella* is in no way more degenerated than the other lernaeocerid genera. More over *Pennella* has antennules and antennae exactly as in others. A careful study of its oral appendages is therefore necessary.

Though eleven species have been recorded from the Indian waters some of them were made synonyms. The accompanying key is very unsatisfactory since it is based entirely on published information which is not very satisfactory.

*Key to species of* **Pennella**

| | | |
|---|---|---|
| 1. | Abdominal processes in two rows | .2 |
| — | Abdominal processes not in two rows | 7 |
| 2. | Abdominal processes short and club-shaped, only slightly longer than broad | *selaris* Kirtisinghe |
| — | Abdominal processes cylindrical, much longer than broad | .3 |
| 3. | Abdominal processes unbranched | *diodontis* Oken |
| — | Abdominal processes branched | .4 |
| 4. | Neck not clearly demarcated from trunk | *robusta* Gnanamuthu |
| — | Neck clearly demarcated from trunk | .5 |
| 5. | Head dorso-ventrally flattened, cephalic processes unbranched | *platycephala* Gnanamuthu |
| — | Head not dorso-ventrally flattened, cephalic processes branched | .6 |
| 6. | Head with deep dorso-median groove | *elegans* Gnanamuthu |
| — | Head with dorso-median projection or boss | *longicauda* Gnanamuthu |
| 7. | Cephalic processes directed straight backwards, oral surface anterior | *instructa* Wilson |
| — | Cephalic processes directed outwards and backwards, oral area ventral | *biloba* Kirtisinghe |

## **Pennella robusta** Gnanamuthu

*Pennella robusta* Gnanamuthu, 1957, p. 119, figs. 1-6 ; Yamaguti, 1963, p. 208, pl. 229, fig. 1.

*Female.*—Head nearly rectangular, with two anterolateral prolongations irregularly dividing into two bunches of papillose processes. Oral region with a semicircle of smaller papillae with a gap posteriorly. Posterior horns two, longer than head and directed outwards and backwards. Neck rather long, according to Gnanamuthu 18 mm. in length, gradually expanding into the trunk which is 15 mm long, trunk comparatively broad. Abdomen 7 mm long, cylindrical and narrower than the genital part of trunk. Caudal rami tumid, without setae. Abdominal processes seventeen pairs, some of them unbranched, others branched once.

Antennule short, three-jointed, each segment with a long spine ? Antenna three-jointed, short and chelate. Legs represented by the basipods, rami according to Gnanamuthu represented by pointed tooth-like structures.

*Length.*—55.0 mm.

*Host.—Parexocoetus brachypterus.*

*Distribution.*—India (Madras).

*Remarks.*—According to Gnanamuthu this species can be distinguished by its uniformly stout body, short antennule and antenna, long neck which is longer than the genital part of trunk and the simple abdominal processes branched only once. The description contains a few obvious mistakes.

### **Pennella platycephala** Gnanamuthu

*Pennella platycephalus* Gnanamuthu, 1957, p. 121, figs. 7-13 ; Yamaguti, 1963, P. 208, pl. 229, fig. 3.

*Female.*—Head nearly circular, dorso-ventrally flattened, dorsal side with antero-median longitudinal groove. Antero-lateral parts produced forwards into large irregular lobes, ventral side with a cluster of rounded or oval irregularly placed papillae. Posterior horns subsimilar, as long as head, directed outwards and backwards. Neck long and slender, 14 mm long, genital part of trunk enlarged, 10 mm long. Abdomen shorter than genital part of trunk, posteriorly cleft, with sixteen pairs of processes, branched thrice in succession.

*Length.*—37.0 mm.

*Host.—Cypselurus spilopterus.*

*Distribution.*—India (Madras).

*Remarks.*—The short but stout genital part of trunk, highly branched abdominal processes and the circular dorsoventrally flattened head distinguish this species.

### **Pennella elegans** Gnanamuthu

*Pennella elegans* Gnanamuthu, 1957, p. 122, figs. 14-19 ; Yamaguti, 1963, p. 207.

*Female.*—Cephalic horns longer than head. Head with antero median cleft, anterior half of head covered with papillae, those on

the dorsal side large but the ventral ones smaller and mingling with the oral papillae leaving the periphery of the head alone free of papillae. Neck longer than genital part of trunk (15 and 11 mm respectively). Abdomen comparatively short, 5.5 mm long, with eighteen pairs of processes not branched more than once, branches highly dissimilar.

*Length.*—35.0 mm.

*Host.*—*Cypselurus* sp.

*Distribution.*—India (Madras).

*Remarks.*—In general shape this species closely resembles *P. platycephala* but differs in the mode of branching of the cephalic and abdominal processes.

### **Pennella longicauda** Gnanamuthu

*Pennella longicauda* Gnanamuthu, 1957, p. 124, figs. 20-26 ; Yamaguti, 1963, p. 208, pl. 227, fig. 2.

*Female.*—Head circular, dorso-ventrally flattened, the entire ventral side covered with irregularly arranged papillae. Dorso-median part of head raised. Cephalic horns longer than head. Neck slender, nearly as long as genital part of trunk, latter twice as broad as former. Abdominal part of trunk long and slender, with twentytwo pairs of processes, comparatively long and not branched more than once.

*Length.*—35.0 mm.

*Host.*—*Cypselurus bahiensis.*

*Distribution.*—India (Madras).

*Remarks.*—The four species described above were collected from flying fishes at the same locality. The illustrations and descriptions do not clearly bring out the specific characters. Each species needs a redescription, but this is not possible unless they are collected again. Gnanamuthu's collection is untraceable.

## **Pennella instructa** Wilson

*Pennella instructa* Wilson, 1971, p. 122, pl. 18 ; 1932, p.491, fig. 295; Yamaguti, 1939b, p. 483, pl. 33, fig. 193 ; Heegaard, 1962, p. 186 ; Kirtisinghe, 1964, p. 110, fig. 153.
*Pennella zeylanica* Kirtisinghe, 1932, p. 137, figs. 1-5.

*Female.*—Head nearly spherical, oral surface truncated and with two pairs of crescentic masses of small papillae disposed in the dorso-ventral direction. The inner group of papillae separated from the outer by a distinct gap. A few scattered papillae connect the ends of the outer crescents. Postero-lateral parts of head produced backwards into a pair of identical horns steadily narrowing towards their tip, horns longer than head. Neck comparatively long, longer than genital part of trunk. Abdomen about half the length of the genital part, its ventral and ventro-lateral areas covered with processes which branch extensively forming a thick matting of processes. Legs one and two placed close to each other, third and fourth slightly away from second and themselves placed wide apart.

*Length.*—135.0 mm.

*Host.—Histiophorus gladius, Xiphias gladius, Istiompax australis.*

*Distribution.*—East coast of America, Japan, Australia, Sri Lanka.

*Remarks.*—Kirtisinghe himself made *P. zeylanica* a synonym of *P. instructa. P. instructa* is one of the species with very distinct characters.

Lewis (1967) gave a detailed description of *P. histiophori* Thomson (1889) and suggested that *P. zeylanica* might be a synonym of this species. His identification of *P. histiophori* was made with reservation. Nevertheless it would appear that *P. instructa* Wilson and *P. zeylanica* Kirtisinghe are synonyms of *P. histiophori* Thomson. As remarked by Lewis the taxonomy of this genus is at present very confused. This is because a majority of the species are badly illustrated.

## **Pennella biloba** Kirtisinghe

*Pennella biloba* Kirtisinghe, 1933, p. 549, figs. 1-3 ; 1964, p. 111 ; Yamaguti, 1963, p. 207.

*Female.*—Head much broader than long, antero-laterally expanded into large rounded lobes demarcated from the median part by two oblique lateral grooves ? Ventral surface of head with small papillae surrounding the mouth and larger ones more peripherally. Cephalic horns much longer than head, directed obliquely backwards. Neck as long as genital part of trunk, latter cylindrical. Abdomen slightly shorter than genital part of trunk, ventrally covered with closely packed short unbranched processes.

*Length.*—32.0 mm.

*Host.*—*Makaira indica*, *Histiophorus brevirostris.*

*Distribution.*—Sri Lanka.

## **Pennella diodontis** Oken

*Pennella diodontis* Oken, 1816, p. 358 ; Kirtisinghe, 1935, p. 332, figs. 1-6 ; 1964, p. 112, fig. 155 ; Yamaguti, 1963, p. 207.
*Pennella cervicornis* Heegaard, 1943 b, p. 28, figs. 79-81 ; Yamaguti, 1963, p. 207, pl. 228, fig. 4.

*Female.*—Head somewhat rounded, antero-lateral parts produced forwards into two large horns irregularly dividing into a limited number of branches. Border of head between the horns deeply concave with the antennae situated at the bottom of the concavity. Ventral side with small papillae around mouth and larger ones more peripherally. Cephalic horns large, directed obliquely outwards and slightly narrowing. Neck cylindrical, not much narrower than trunk, merging imperciptibly into the latter. Genital part of trunk as long as neck. Abdomen short, with two rows of unbranched lateral processes.

*Length.*—14 mm.

*Host.*—*Diodon* sp., *D. maculifer*, *D. sexmaculatus*, *D. maculatus.*

*Distribution.*—Antarctic, Manila, Sri Lanka, Bay of Bengal.

*Remarks.*—The specimen figured by Heegaard is much different in shape but as observed by Kirtisinghe it is distorted. Heegaard has given a lateral view which also must have given it a different shape. The shape of its head however shows its identity with the present species.

### **Pennella selaris** Kirtisinghe

*Pennella selaris* Kirtisinghe, 1964, p. 112, figs. 156-157.

*Female.*—Head together with the processes longer than broad, antero-lateral parts of head ventrally produced into processes dividing into branches more or less as in *P. diodontis* Oken. Cephalic horns rather stout, apically blunt and of uniform width. Neck rather slender, not clearly demarcated from genital part of trunk, more than twice as long as the latter. Abdominal part only slightly shorter than genital part, as broad as neck, with two rows of about twenty pairs of short club-shaped processes.

*Length.*—29.5 mm.

*Host.*—*Selar malam.*

*Distribution.*—Sri Lanka.

## Genus **Peroderma** Heller

*Peroderma* Heller, 1868, p. 25 ; Bassett-Smith, 1898a, p. 12 ; Bennet, 1961, p. 70 ; Yamaguti, 1963, p. 210.

*Diagnosis.*—Body composed of head, neck and trunk. Head and neck connected to trunk at right angles below the anterior end. Head covered with a bunch of irregular lobes and a cluster of long branched processes. Neck very short, carrying four pairs of legs. Trunk large, swollen, not demarcated into genital and abdominal parts. Caudal rami small. Egg tubes long. Cephalic appendages as in the family.

Parasites of teleosts.

Type species.—*P. cylindricum* Heller.

*Discussion.*—Four species, namely, *P. cylindricum* Heller, *P. branchiata* Bassett-Smith, *P. petersi* Richiardi and *P. belloti* Richiardi have so far been placed under this genus. Bassett Smith himself made *P. branchiata* a synonym of *P. cylindricum*. According to Wilson (1917) the other two species do not belong to *Peroderma*.

In the diagnosis of the family Yamaguti observed that the head is not provided with any attachment processes and that the oral appendages are reduced. But in plate 231 Yamaguti has reproduced the figures of the cephalic processes from Nunes Ruivo (1954). The recent study of *P. cylindricum* by Bennet (1961) and Ho (1966b) has shown that *Peroderma* has all the appendages of lernaeocerids.

### **Peroderma cylindricum** Heller

*Peroderma cylindricum* Heller, 1968, p. 250, pl. 25, fig. 6 ; Brian, 1906, p. 93 ; Bennet, 1961 ; p. 70, figs. 1-2 ; Yamaguti, 1963, p. 210, pl. 231, fig. 1 ; Ho, 1966b, p. 195, figs. 87-100.
*Peroderma branchiata* Bassett-Smith, 1898a, p. 13, pl. 7, fig. 2.

*Female.*—Head globular, covered by a hood composed of short irregularly branched horns remotely resembling that of *Cardiodectes*. From the antero-ventral part originates a bunch of dichotomously branched processes radiating in a semicircle, according to Bennet, originating from a common base. Nunes-Ruivo illustrated two contiguous processes. Neck narrower than head but of the same length as the latter, placed at right angles to trunk. Trunk stout and cylindrical, produced beyond the point of insertion of the neck. Its hind end bilobed, carrying a pair of caudal rami with four setae, one of the setae very long. An abdominal lobe clearly visible. Egg tubes very long, straight, with a single row of eggs.

Antennule three-jointed, cylindrical and sparsely setose. Antenna three-jointed, chelate, movable finger with inner basal seta, fixed finger excavated, with serrate margin. Mandible short and blunt, without teeth. Maxillule with two long spines and a basal tubercle with a setule. Maxilla three-jointed, segments one and two with processes, third with frilled border. Legs one and two biramous, rami two-jointed, with long plumose setae, outer ramus with outer spines. Third leg uniramous. Legs showing no degeneration, even the intercoxal plates being normal.

*Length.*—9.5 mm.

*Host.—Sardinella albella, S. eba, Sardina pilchardus, Coilia dussumieri, Ethmalosa dorsalis.*

*Distribution.*—Mediterranean, Mauritania, Angola, India (Bombay, Mandapam).

## SUBORDER *LERNAEOPODOIDA*

*Diagnosis.*—Body demarcated into cephalothorax and trunk. Trunk anteriorly narrowed to form a long or short neck. Segmentation absent. Cephalothorax rarely with lobes, usually covered by a carapace. Neck with or without lobes or processes. Trunk enlarged, somewhat dorso-ventrally flattened, with or without posterior trunk processes, branched or unbranched. A small genital or abdominal process may be present. Caudal rami present or absent. Egg sacs cylindrical, eggs multiseriate.

Antennule small, segmented, with spine-like setae, rarely absent. Antenna uniramous or biramous, generally flattened, not prehensile. Proboscis present or absent. Mandible distally serrated. Maxillule with long stem having stout apical processes, palp present. Maxillae converted into fleshy attachment organs or absent. Maxillipeds generally prehensile, in front of maxillae or behind. Legs absent, except for vestiges in *Clavellisa.*

Male a dwarf attached to the female, capable of moving about on the female.

### *Key to families of LERNAEOPODOIDA*

1. Female attached to host with the help of the modified maxillae — LERNAEOPODIDAE
— Female attached to host by burrying the head in the body of the host — SPHYRIIDAE

## Family LERNAEOPODIDAE

*Diagnosis.*—Body demarcated into cephalothorax (head and neck) and trunk. Trunk generally swollen, with or without posterior

processes. Abdomen and caudal rami generally absent. A median genital process often present. Egg sacs stout, eggs multiseriate, closely packed and generally polygonal. Antennule small, segmented, with spine-like setae. Antenna flattened, usually biramous, rami indistinctly segmented, with spines, surface often spinulose. Mouth opening fringed with stiff hairs. Mandible distally flattened, with blunt teeth, often in two series. Maxillule cylindrical, with two to three apical spines, palp with two or more spines. Maxillae behind maxillipeds (except in *Lernaeopoda*), fused or separate, long or short, joined to a bulla embedded in the tissue of the host. Maxillipeds two-jointed and prehensile. Thoracic appendages absent, except for vestiges in *Clavellisa*.

Male a pigmy attached to the female, capable of moving on the female. Cephalothorax demarcated from trunk or not, latter sometimes indistinctly segmented. Antennule as in female. Antenna not much flattened, distinctly biramous, endopod with strong spines. Maxilla and maxilliped swollen, subchelate.

Type genus.—*Lernaeopoda* Blainville.

*Discussion.*—According to Yamaguti (1963) this family includes four subfamilies, Lernaeopodinae, Tracheliastinae, Brianellinae and Clavellinae. Clavellinae includes two distinct groups of genera, *Brachiella* type and *Clavella* type, the former with trunk processes and the latter generally without. More over the *Brachiella* male has its trunk demarcated from cephalothorax by a narrow waist while in the *Clavella* male the trunk and cephalothorax are fully fused. There is thus sufficient grounds for splitting the Clavellinae into two subfamilies, Brachiellinae and Clavellinae. But according to Kabata (1973b) the status of the genus *Brachiella* is still uncertain. This genus as at present constituted is a heterogeneous assemblage. Kabata further observed that the *Brachiella* group of lernaeopodids are associated with highly advanced and actively evolving fishes and are themselves undergoing active evolution. Their morphological flexibility poses problems to the taxonomist.

The extensive studies conducted by Kabata on lernaeopodids indicate that the relation among the various genera is not yet clearly understood. The definitions of the genera available are those

proposed by Wilson (1915) which are admittedly not fully satisfactory. The correct placing of some species is even now difficult.

*Key to subfamilies of* LERNAEOPODIDAE

1. Maxillipeds inside maxillae, placed behind the mouth tube, cephalothorax in line with trunk or inclined forwards — LERNAEOPODINAE
— Maxillipeds close to mouth tube, maxillae far behind maxillipeds, cephalothorax in line with trunk or inclined backwards — CLAVELLINAE

## Subfamily LERNAEOPODINAE

*Diagnosis.*—Cephalothorax shorter than maxillae, in line with the trunk or slightly bent forwards. Neck very short. Trunk enlarged, with or without posterior processes. Genital lobe may be present. Antennule two to four-jointed. Antenna biramous. Maxillae long, separate. Maxillipeds placed between the maxillae or just in front, fairly close to the mouth tube.

Cephalothorax of male clearly demarcated from trunk, latter faintly segmented. Caudal rami present, often large.

### Genus **Lernaeopoda** Blainville

*Lernaeopoda* Blainville, 1822, p. 442 ; Wilson, 1915, p. 631 ; Leigh-Sharpe, 1919, p. 256 ; Barnard, 1955, p. 290 ; Yamaguti, 1963, p. 223.

*Diagnosis.*—Cephalothorax inclined forwards, short, with carapace. One or more trunk segments often indicated. Genital process and posterior trunk processes may be present, ventral to egg sacs. Abdomen and caudal rami absent. Maxillae free, generally as long as trunk. Maxillipeds between the maxillae or just in front.

Male with cephalothorax swollen, separated from trunk by distinct waist, trunk often indistinctly segmented. Caudal rami often present, large and curving dorsalwards.

Parasites of elasmobranchs and teleosts.

Type species.—*L. brongniartii* Blainville.

*Key to species of* **Lernaeopoda**

| | | |
|---|---|---|
| 1. | Maxillipeds placed between maxillae, cephalothorax almost bent at right angles to trunk | *scoliodontis* Kirtisinghe |
| — | Maxillipeds placed in front of maxillae, cephalothorax in line with trunk | 2 |
| 2. | Trunk about twice as long as cephalothorax | *upenei* Pellai |
| — | Trunk as long as cephalothorax | *stromatei* Gnanamuthu |

## **Lernaeopoda upenei** Pillai
(Fig. 257)

*Lernaeopoda upenei* Pillai, 1962d, p. 58, fig. 1 ; 1967d, p. 1656, fig. 237.

*Female.*—Cephalothorax inclined forwards, dorsally covered by a carapace. Neck very short, as broad as cephalothorax. Trunk gradually widening backwards, broadest at the hind end, abdomen absent. Posterior trunk processes elongate ovate, postero-median part with indistinct genital lobe.

Antennule four-segmented, first segment somewhat swollen, fourth armed with four spines, two of them short and blunt, others acute. Antenna biramous, both rami armed with spinules, inner two-jointed, with three apical spines. Mandible broad throughout, with six primary teeth, second and third alternating with secondary teeth. Maxillule with two stout apical spines, palp small, with two slender spines. Maxillae long, slightly shorter than trunk, fully free, bulla elongated and apically flared. Basal segment of maxilliped with long inner median spine, border beyond the spine bilobed and spiny, distal segment with a basal spine and lower distal serrated crest ending in two spines, unguis long, slender and moderately curved.

*Length.*—3.3 mm.

*Male.*—Cephalothorax large, demarcated from trunk by a narrow waist, the whole body covered by a loose jacket. Carapace distinct. Caudal rami absent. Antennule three-segmented, first segment subequal to third in length, with outer distal seta, third segment with one short and two long spines. Outer lobe of antenna

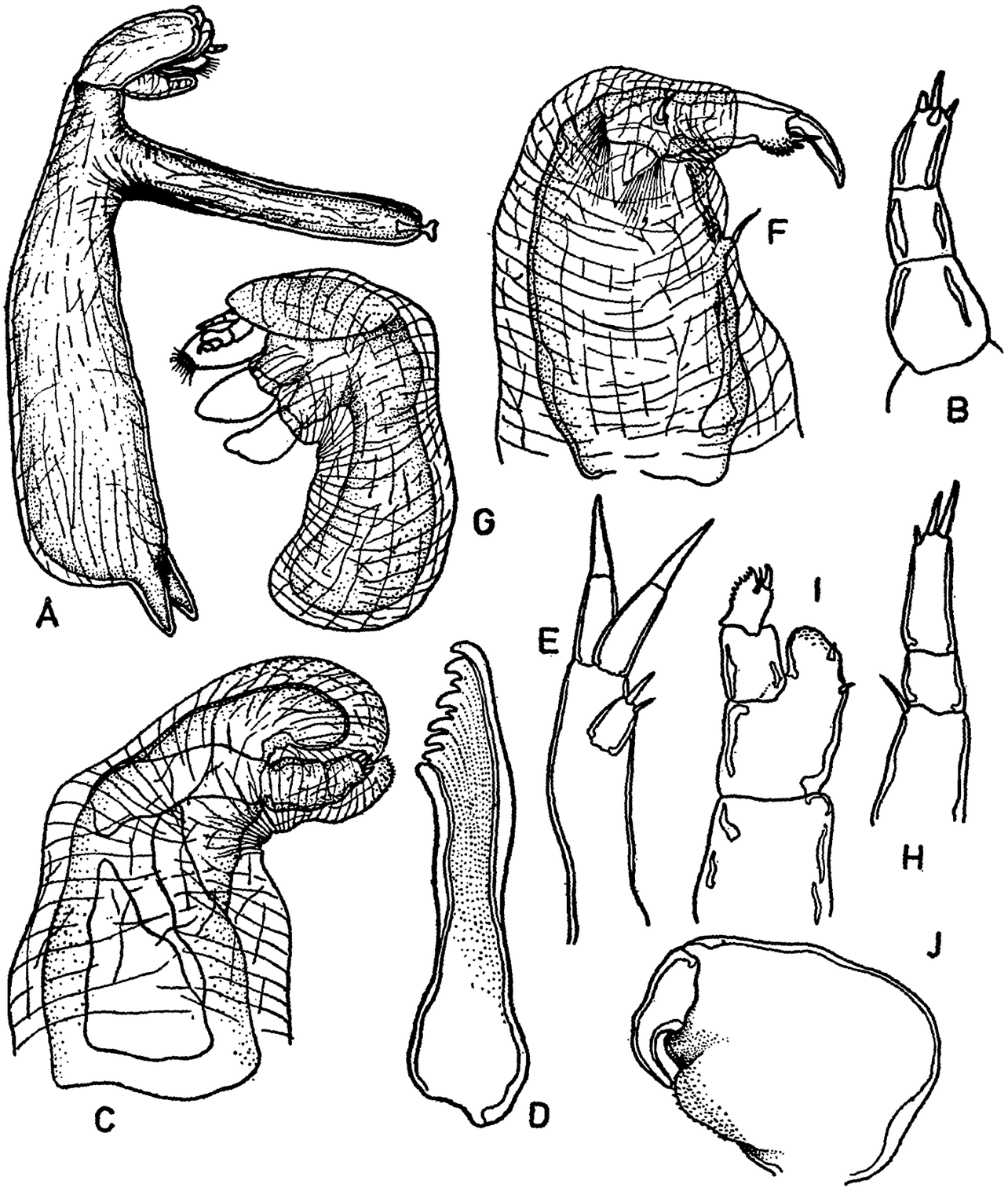


Fig. 257. *Lernaeopoda upenei* Pillai : A, female, lateral view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxilliped ; G, male ; H, antennule ; I, antenna ; J, maxillule.

externally spinulose and armed with two spines, inner lobe two-jointed, distal segment produced into an internally serrate lobe, outer spine short and claw-like, with a seta near its base. Maxillule similar to that of female. Maxilla subchelate, distal claw-like segment folding against a spiny lobe on the basal segment. Maxilliped similar to the maxilla, lobe on second segment unarmed, distal segment short and stumpy.

*Length.*—0.8 mm.

*Host.—Upeneus vittatus.*

*Distribution.*—India (Kerala).

*Type.*—In the National Zoological collection at Zoological Survey of India, Calcutta. Reg. No. C2165/2.

### **Lernaeopoda stromatei** Gnanamuthu
(Fig. 258)

*Lernaeopoda stromatei* Gnanamuthu, 1950f, p. 175, figs. 1-15 ; Pillai, 1967d, p. 1656, fig. 236.

*Female.*—Cephalothorax comparatively very large, much broader than trunk, the large projecting antennae increasing the diamentions of the cephalothorax outwards and forwards. Anterior border of cephalothorax narrow, wedged between the antennae. Cephalothorax narrowing backwards, continuing as the comparatively short trunk, latter widening backwards. Genital lobe indistinct. Posterior trunk processes large, elongate oblong.

Antennule three or four-jointed, distal segment with three distal spines. Antenna large, exopod much larger than endopod, latter three-segmented and with three apical spines. Mandible with eight large primary teeth, first two alternating with two subsidiary teeth. Maxillule with slightly curved stem, apex with two short outer and a long inner spine, palp with two small spines. Maxillae nearly as long as cephalothorax, fully free, bulla mushroom-shaped. Maxilliped with large basal segment carrying an inner median spine, distal segment slender, its lower border distally serrated and ending in a sharp spine, unguis slender and slightly curved.

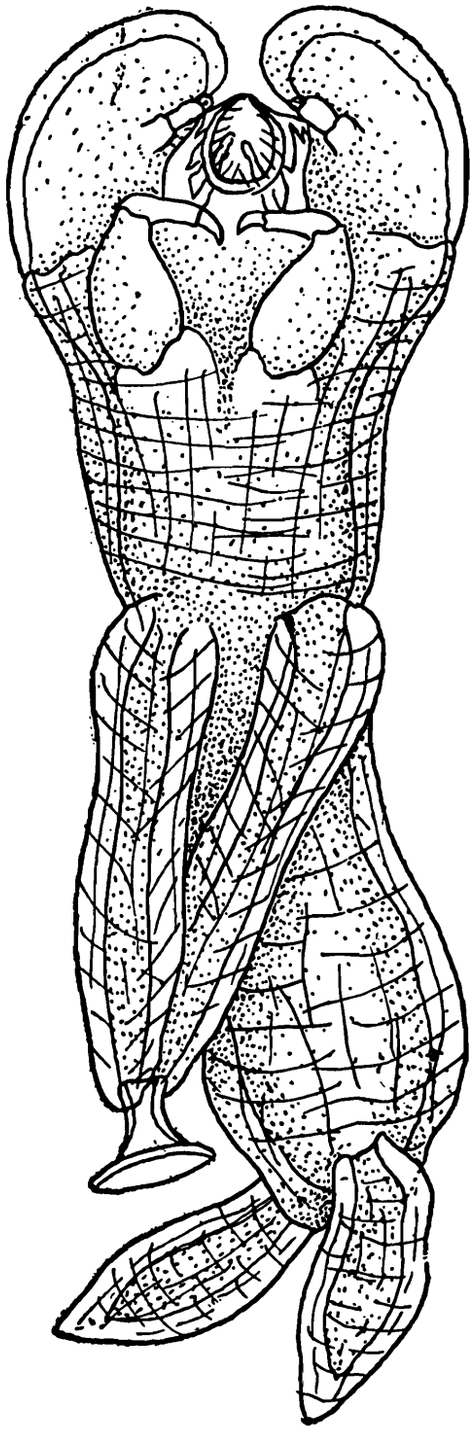

Fig. 258. *Lernaeopoda stromatei* Gnanamuthu : Female, ventral view.

*Length.*—2.3 mm.

*Host.—Parastromateus niger.*

*Distribution.*—India (Madras, Kerala).

*Remarks.*—The above description is based mainly on an unpublished work by my former student Dr. S. M. Hameed. He had

only a single specimen which he decapitated to study the appendages. This is unfortunate since the type specimen is untraceable.

This species, if it actually belongs to *Lernaeopoda*, is an aberrant member of the genus. Both Gnanamuthu and Hameed had only a single specimen without egg sacs. The specimens appear very much like juveniles. *Parastromateus niger* always carries *Thysanote appendiculata*. Hence there is the possibility that *L. stromatei* represents the juvenile stage of *T appendiculata*. The position of the maxillipeds far in front of the maxillae is significant.

## **Lernaeopoda scoliodontis** Kirtisinghe
(Fig. 259)

*Lernaeopoda scoliodontis* Kirtisinghe, 1964, p. 117, fig. 169.

*Female*.—Body clearly demarcated into cephalothorax, neck and trunk by distinct septa. Cephalothorax slightly longer than broad and oriented almost at right angles to the neck. Neck shorter and narrower than cephalothorax, trunk very long, regularly broadening backwards, its hind border with small bilobed genital process and a pair of large digitiform trunk processes.

Antennule three-or four-jointed, basal segment stout, with long inner distal spine, third segment with two blunt and two sharp spines. Antenna biramous, endopod indistinctly three-or four-ointed, apical segment with two short spines, exopod comparatively small, with an apical patch of spinules. Mandible distally broad, with eight primary teeth, first three alternating with secondary teeth, first four primary teeth blunt and large, others sharp. Maxillule with three stout distal processes, palp rather large, with two short spines. Maxillae long, slender, nearly as long as trunk and completely free. Basal segment of maxilliped with a proximal and a distal patch of sharp teeth, the short border separating the patches of spines highly concave, housing an irregular process to which is attached a spine at right angles. Distal half of inner border of distal segment serrated and ending in a spine. Unguis moderately long and curved, with a proximal inner accessory process.

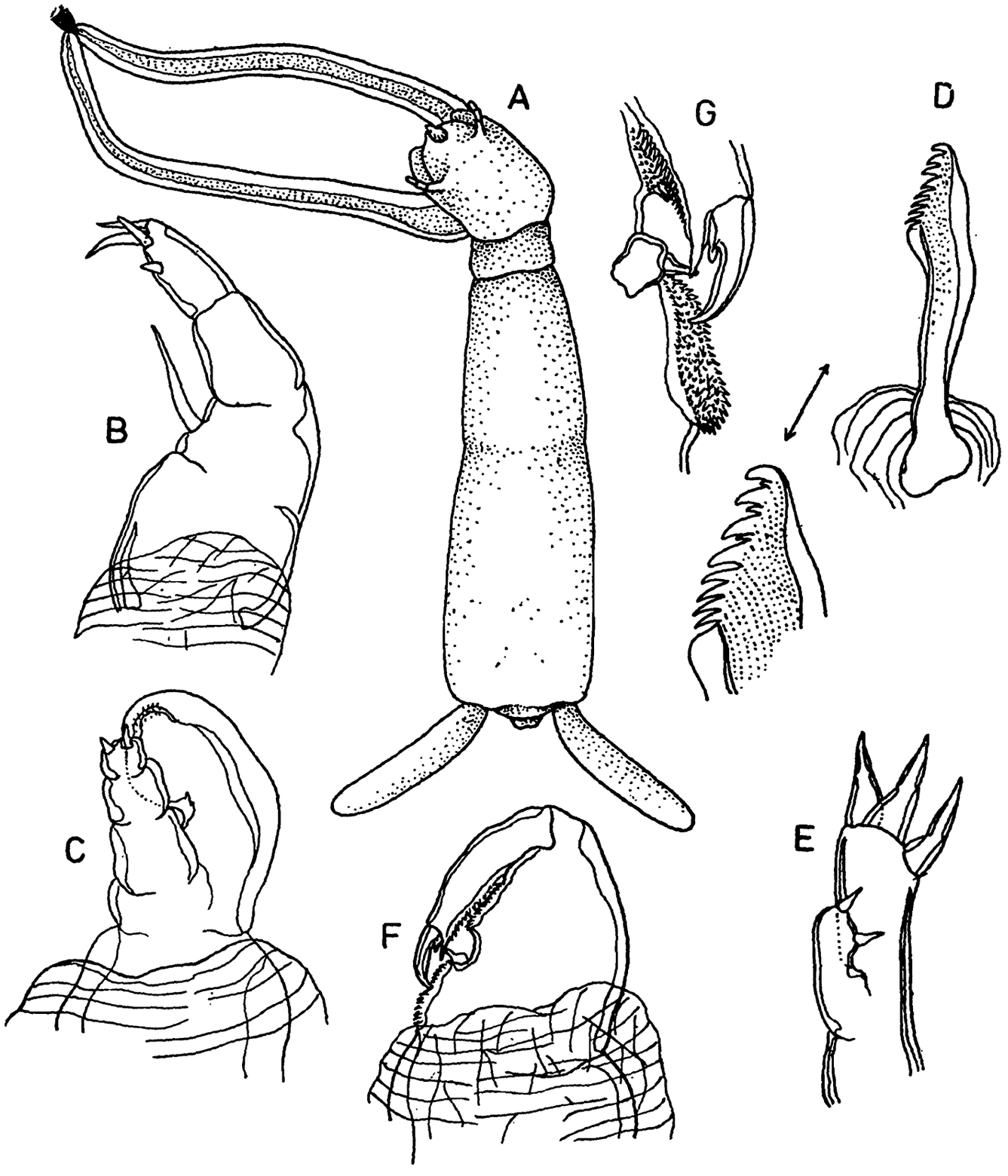


Fig. 259. *Lernaeopoda scoliodontis* Kirtisinghe : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxilluiped ; G, same, tip enlarged.

*Length.*—7.3 mm.

*Host.*—*Scoliodon walbeehmi*, *Zygaena* sp.

*Distribution.*—Sri Lanka, India (Kerala).

## Subfamily CLAVELLINAE

*Diagnosis.*—Cephalothorax bent backwards, often resting on the dorsal side of the trunk, usually long and slender. Trunk dorsoventrally flattened, with or without posterior trunk processes. Genital process present, abdomen and caudal rami usually absent. Antennule two-to four-segmented. Antenna uniramous or biramous. Maxillule with two or three apical spines. Maxillae far behind maxillipeds, free or fused, may be very short. Maxilliped close to mouth tube.

Male with cephalothorax and trunk fused or separated by a narrow waist. Trunk with or without faint segmentation. Caudal rami present or absent.

Parasites of teleosts and elasmobranchs.

*Discussion.*—This subfamily as already stated includes two groups of genera, brachielliform and clavelliform. Since Yamaguti (1963) published his monograph considerable additions have been made to this subfamily and a lot of rearrangement has also been effected. Kabata (1964c) divided *Charopinus* into five genera, *Charopinus*, *Pseudocharopinus*, *Schistobranchia*, *Dendrapta* and *Charopinopsis*. Heegaard (1940) created *Anaclavella* and Pillai (1969) showed that *Thysanotella* Bassett-Smith is a synonym of *Thysanote*. While creating *Proclavellodes* Kabata (1967b) observed that the subfamily Clavellinae occupies a puzzling position in the family Lernaeopodidae, its members being highly specialised, with appendages undergoing extensive changes during ontogeny. The relationship of the genera within the subfamily is yet to be properly assessed.

### *Key to genera of* CLAVELLINAE

1. Maxillae or trunk or both with fimbriate processes **Thysanote** Kroyer
— Maxillae and trunk without fimbriate processes 2

| | | |
|---|---|---|
| 2. | Maxillae long, separate | .3 |
| — | Maxillae short, separate or partially fused | .5 |
| 3. | Trunk with a single pair of posterior processes | **Pseudocharopinus** Kabata |
| — | Trunk with two pairs of posterior processes | .4 |
| 4. | Trunk highly flattened, cephalothorax more or less in line with trunk | **Charopinopsis** Yamaguit |
| — | Trunk not flattened, cephalothorax curved dorsalwards | **Brachiella** Cuvier |
| 5. | Cephalothorax originating from middle of dorsal side of trunk | **Clavellisa** Wilson |
| — | Cephalothorax originating from anterior end of trunk | .6 |
| 6. | Trunk with two pairs of posterior processes | **Isobranchia** Heegaard |
| — | Trunk without posterior processes | 7 |
| 7. | Maxillae very short, with basal wing-like expansion, neck slender and long | **Proclavellodes** Kabata |
| — | Maxillae not very short, without basal wing-like expansion, neck neither long nor slender | **Clavellopsis** Wilson |

## Genus **Thysanote** Kroyer

*Thysanote :* Wilson, 1951, p. 650 ; Yamaguti, 1963, p. 262.
*Thysanotella* Wilson, 1915, p. 651 ; Yamaguti, 1963, p. 264.

*Diagnosis.*—Cephalothorax short, usually in line with the trunk. Carapace rather indistinct. Trunk large, dorso-ventrally flattened and broadening backwards. Genital process, abdomen and caudal rami absent. Branched or unbranched processes at hind end of trunk, postero-median pair always unbranched. Antennule four-jointed. Antenna biramous, endopod two-jointed. Mandible with oblique row of teeth. Maxillule stout, palp small. Maxillae short, free, with or without processes. Maxillipeds prehensile.

Male distinctly brachielliform. Cephalothorax demarcated from trunk by a distinct waist. Carapace absent. Caudal rami present.

Parasites of teleosts.

Type species.—*T pomacanthii* (Kroyer).

*Discussion.*—Ten species have so far been recorded from Indian waters. Of these one was described without a specific name for

want of sufficient material. *T octofimbriata* Tripathi (1962b) and *T decemfimbriata* Pillai (1962d) are synonyms of *T eleutheronemi* Rangnekar (1961).

*Key to species of* **Thysanote**

| | | |
|---|---|---|
| 1. | Cephalothorax longer than trunk, processes on trunk and maxillae unbranched | *rastrelligeri* Rangnekar |
| — | Cephalothorax shorter than trunk, at least some of the processes on trunk and maxillae branched | .2 |
| 2. | Processes on trunk unbranched | .3 |
| — | Processes on trunk branched | .4 |
| 3. | Each maxilla with two dichotomously branched processes, each hind corner of trunk with two processes | *appendiculata* (Stp. & Lutk) |
| — | Each maxilla with four dichotomously branched processes, each hind corner of trunk with four processes | *eleutheronemi* Rangnekar |
| — | Each maxilla with two basal branched processes and one median unbranched process, each hind corner of trunk with three processes | *heterodactyla* Kirtisinghe |
| 4. | Maxilla without processes | .*multifimbriata* (Bassett-Smith) |
| — | Maxilla with processes | .5 |
| 5. | Processes on trunk branched twice. | *longimana* Wilson |
| — | Processes on trunk branched once | .*furcata* Kirtisinghe |

## **Thysanote appendiculata** (Stp. & Lutk.) (Fig. 260)

*Brachiella appendiculata* Stp. & Lutk., 1861, p. 419, pl. 15, fig. 35.
*Brachiella appendiculosa* Bassett-Smith, 1898a, p. 14, pl. 6, figs. 1-3.
*Thysanote appendiculata* Wilson, 1915, p. 651 ; Kirtisinghe, 1935, p. 343, figs. 43-46 ; 1964, p. 114, figs. 160-161 ; Gnanamuthu, 1950c, p. 259 ; figs. 1-3 ; Pillai, 1962d, p. 60, fig. 2 ; 1967d, p. 1651, fig. 240 ; Yamaguti, 1963, p. 263.

*Female.*—Cephalothorax short, slightly bent downwards. Trunk swollen, widening backwards. Head with large carapace. Neck enlarged into hemispherical lobes at the base of the maxillae, housing the maxillary glands. Body enclosed in a feebly wrinkled covering. Postero-lateral parts of trunk with a pair of ventral digitiform processes. Postero-median pair like the lateral ones but shorter and narrowing. Postero-median lobe small.

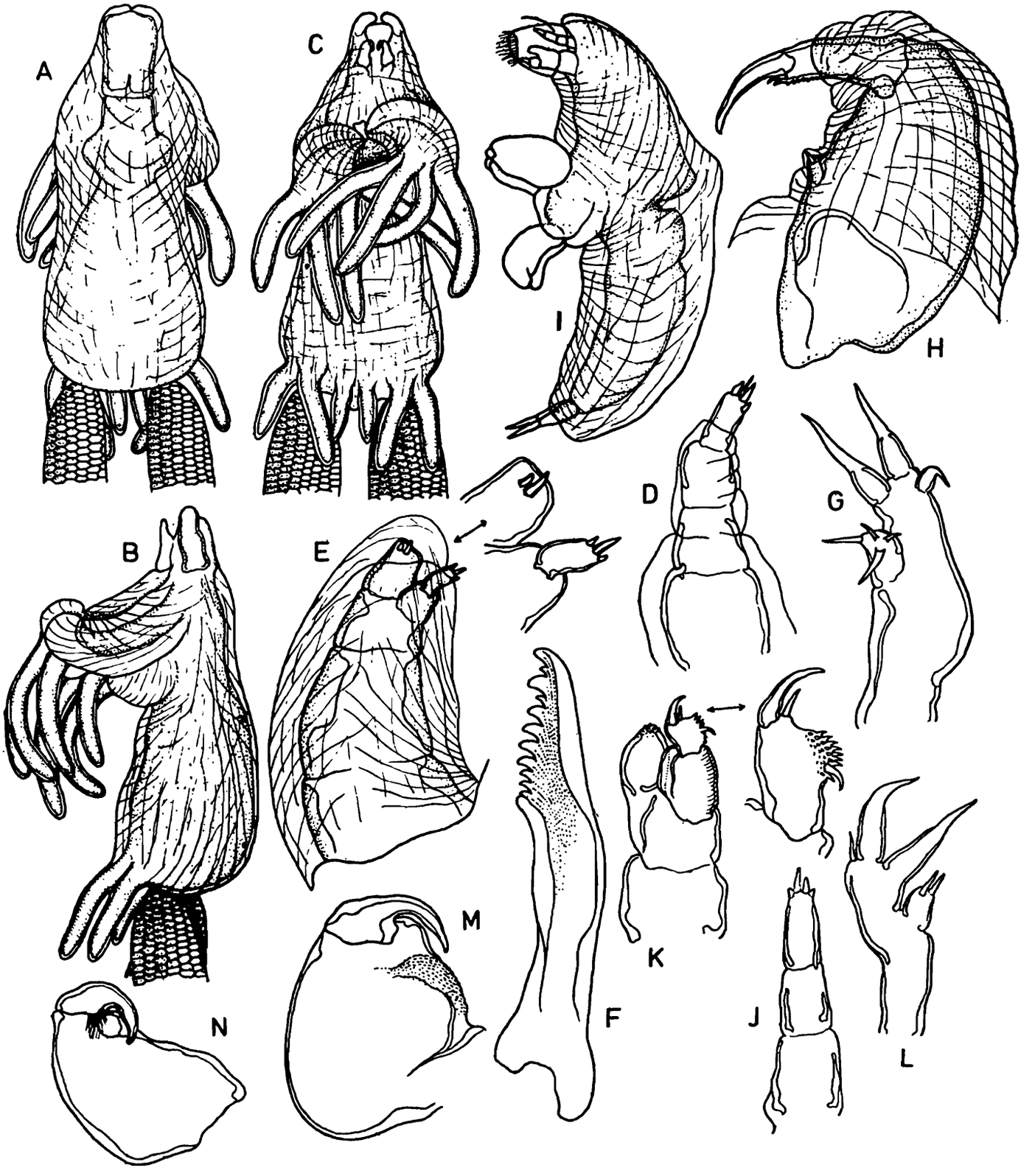


Fig. 260. *Thysanote appendiculata* (Stp. & Lutk.) : A, female, dorsal view; B, same, lateral view ; C, same, ventral view ; D, antennule ; E, antenna; F, mandible ; G, maxillule ; H, maxilliped ; I, male ; J, antennule; K, antenna ; L, maxillule ; M, maxilla ; N, maxilliped.

Antennule four-jointed, rather swollen, fourth segment with short subapical inner spine and two longer apical spines and a seta. Antenna biramous, exopod apically truncated and armed with two spines, endopod two-jointed, distal segment with one long and two short apical spines. Mandible with eight to nine primary teeth, first two alternating with secondary teeth. Maxillule with two long apical spines and a small outer spine, palp with two long and two short spines. Maxillae short but stout, free, bulla vine glass-shaped. Each maxilla with two pairs of short digitiform processes originating from the middle of its ventral side. Basal segment of maxilliped very large, with median inner protuberance armed with a spine, distal segment slender, apex demarcated as a slightly curved unguis, ventral border near the base of the unguis with a row of sharp teeth ending in two spines.

*Length.*—5-7 mm.

*Male.*—Body slightly curved, narrowing towards both ends. Cephalothorax separated from trunk by a deep dorsal sinus. Antennule three-jointed, apical segment with two short and two long spines. Protopod of antenna two-jointed, exopod with a few apical tubercles, endopod two-jointed, basal segment internally grooved, distal segment with inner bulge carrying a curved spine and a cluster of sharp denticles, inner distal angle with a sharp spine, unguis long and claw-like. Maxillule with two stout apical spines and a small outer spine, palp with two spines. Maxilla and maxilliped with stout basal segment, distal segment claw-like, folding against a swelling on the basal segment. Maxilliped longer than maxilla. Caudal rami long and two-jointed, distal segment with basal outer spine and two apical spines.

*Length.*—0.8 mm.

*Host.—Parastromateus niger.*

*Distribution.*—Sri Lanka, India (Bombay, Madras, Kerala).

*Remarks.*—Both Kirtisinghe and Gnanamuthu have described the trunk of the male as three-jointed but I could not see any indication of this. Gnanamuthu has described the maxillae and maxillipeds

of the male as three-segmented but only two segments could be detected. Contrary to Gnanamuthu the antennule of the male is only three-jointed and the terminal segment has four instead of six spines.

The antennule of the female is four and not three-segmented and the terminal segment has one spine and three blunt processes. The palp of the maxillule has four and not two spines.

## **Thysanote longimana** Wilson
(Fig. 261)

*Thysanote longimana* Wilson, 1913, p. 257, pl. 47, figs. 262-264, pl. 48 ; 1915, p. 650 ; Yamaguti, 1963, p. 263, pl. 289, fig. 1.
*Thysanote longimanus* Pillai, 1962d, p. 61, fig. 3 ; 1967d, p. 1657, fig. 239.

*Female.*—Body nearly straight. Cephalothorax comparatively long, about half as long as trunk, carapace distinct. Trunk enlarged at the base of the maxillae and at the hind end. Postero-median part with large bilobed process. Postero-lateral parts of trunk with two pairs of processes, each branched twice so that there are twelve processes in all. Postero-median processes unbranched, narrowing and diverging.

Antennule highly swollen, indistinctly four-jointed, third segment with one and fourth with three spines, all spines short. Outer lobe of antenna comparatively small, with one subapical spine, inner lobe three-jointed, distal segment with two spines. Mandible distally bent inwards, with ten comparatively blunt primary teeth, first alternating with a secondary tooth. Maxillule distally enlarged, with two very stout spines, palp comparatively small, with two spines. Maxillae long, free, apically enlarged into semicircular lobes, bulla vine glass-shaped, each maxilla with a single bifid process near its base and another process dichotomously branched twice in the middle. Basal segment of maxilliped with a bulge carrying a spine at the middle of the inner side, distal part spiny, ventral distal part of distal segment serrated, ending in two spines, unguis slender and well curved.

*Length.*—4.7 mm.

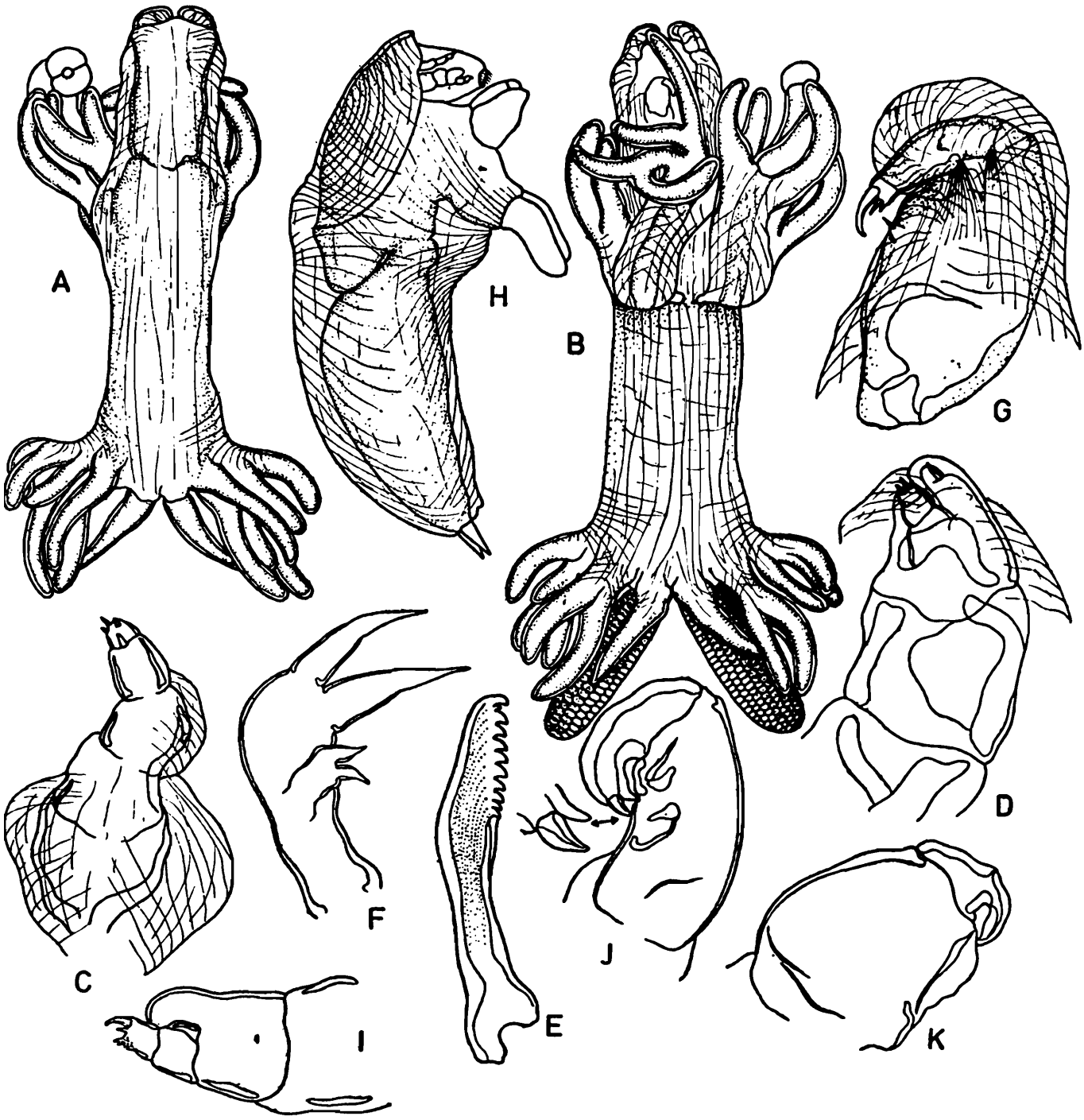


Fig. 261. *Thysanote longimana* Wilson : A, female, dorsal view ; B, same ventral view ; C, antennule ; D, antenna ; E, mandible ; F, maxillule ; G, maxilliped ; H, male ; I, antenna ; J, maxilliped ; K, maxilla.

*Male.*—Body slightly arched, cephalothorax demarcated from trunk by a deep but narrow sinus. Carapace large. Trunk narrowing distalwards, ending in a pair of caudal rami. Outer lobe of antenna unarmed, inner lobe two-jointed, distal segment with a claw, a short spine and a serrated crest. Basal segment of maxilla

conical, distal segment stout and strongly curved. Maxilliped with rectangular basal segment, distal segment strongly curved and produced below the unguis, latter small.

*Length.*—0.8 mm.

*Host.—Neomaenis aya, Carangoides malabaricus.*

*Distribution.*—Jamaica, India (Kerala).

*Remarks.*—The distinguishing character of this species is the secondary branching of the trunk processes. In Wilson's material some of the processes are branched twice but in the present specimen only one of the main branches is secondarily divided. Wilson has shown three spines on the maxillule but I could find only two. Wilson's figure of the maxilliped of the male is inaccurate. This appendage is two-jointed as usual but has many peculiarities.

**Thysanote multifimbriata** (Bassett-Smith)
(Fig. 262)

*Brachiella multifimbriata* Bassett-Smith, 1898b, p. 96, pl. 6, fig. 2.
*Thysanotella multifimbriata* Wilson, 1915, p. 651 ; Yamaguti, 1963, p. 264, pl. 290, fig. 1.
*Thysanote multifimbriata* Pillai, 1969, p. 173, figs. 136-138.

*Female.*—Cephalothorax rather short but stout, cylindrical and curved downwards in the only specimen available. Carapace distinct. Trunk as long as cephalothorax, triangular in outline, swollen and widening backwards, its hind borders oblique. Postero-median part of trunk produced into a prominent bilobed projection. Trunk with four groups of posterior fimbriate processes, a ventro-lateral and a dorso-lateral pair, each group consisting of a pair of very long dichotomously branched processes, in all sixteen processes forming a girdle around the hind end of the trunk. Postero-median part of trunk with a pair of short unbranched processes. Maxillipeds placed slightly away from the oral tube. Maxillae free, fairly long, without processes. Egg sacs as long as body, eggs comparatively small.

*Length.*—7.0 mm.

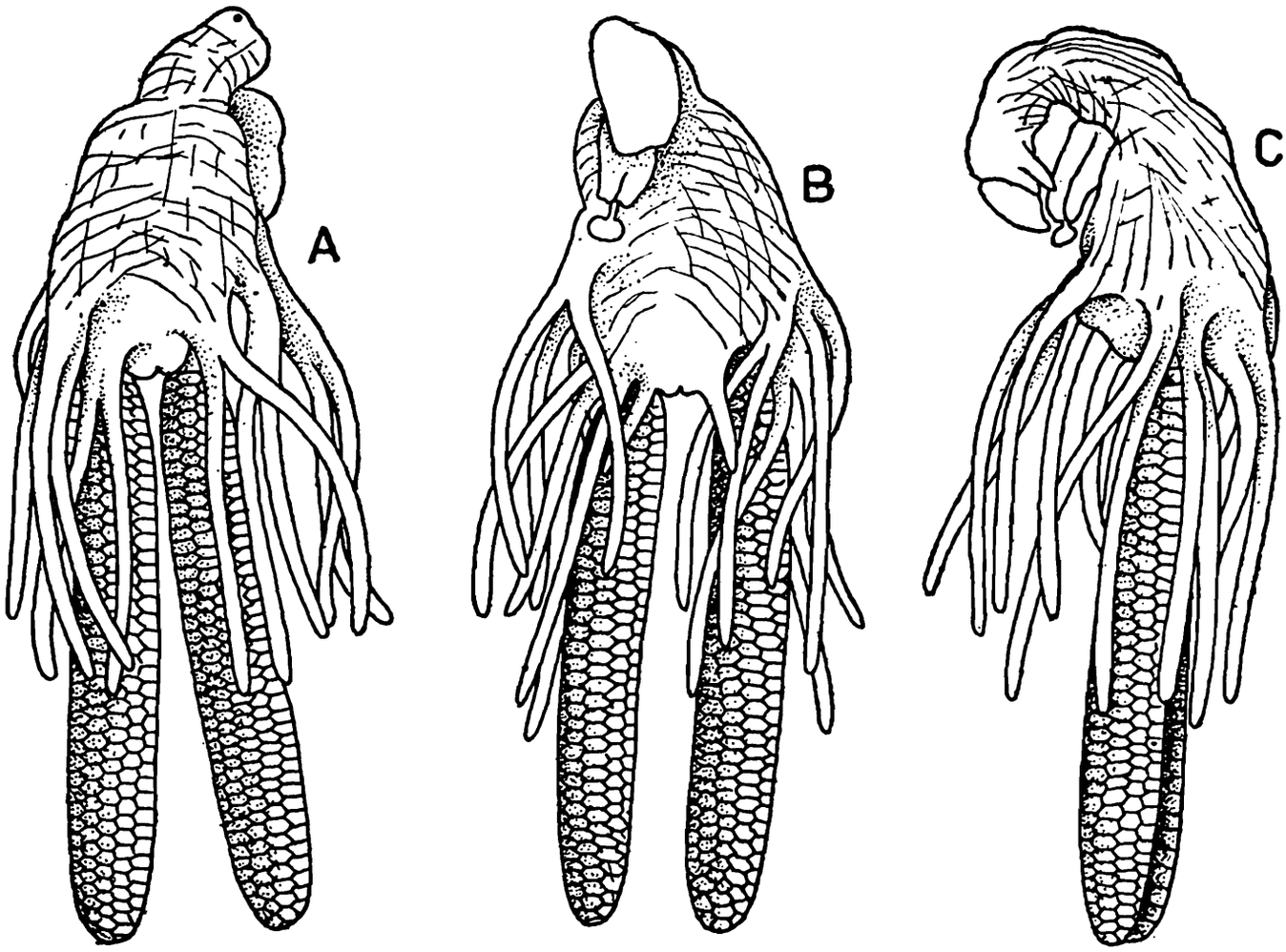


Fig. 262. *Thysanote multifimbriata* (Bassett-Smith) : A, female, dorsal view ; B, same, ventral view ; C, same, lateral view.

*Host.*—*Serranus* sp.

*Distribution.*—Gulf of Oman (Muscat).

*Remarks.*—While revising the family Lernaeopodidae Wilson (1915) transferred those species of *Brachiella* with fimbriate processes to *Thysanote*. Relying on the description given by Bassett-Smith (1898) he created the genus *Thysanotella* for accommodating *Brachiella multifimbriata* Bassett-Smith. I examined the type in the British Museum and it can be seen from the figures that *B. multifimbriata* is a true *Thysanote*.

An important character of this species is the absence of processes on the maxillae. A similar condition is observed in *T gymnobranchiata* Kabata (1968). He did not consider this as sufficient

for creating a new genus. These two species differ in the length of the trunk processes but it should be noted that Kabata's specimen was immature. It is likely that these two species are closely related if not synonymous.

### **Thysanote furcata** Kirtisinghe

*Thysanote furcata* Kirtisinghe, 1964, p. 115, figs. 162-165 ; Pillai, 1967d, p. 1659, figs. 243.

*Female.*—Cephalothorax short, dorso-ventrally flattened. Head covered by a carapace. Trunk twice as long as cephalothorax, gradually widening backwards. Its posterior part with a pair of ventro-median processes and lateral areas with three unbranched processes, a dorsal, a lateral and a ventral. Maxillae as long as cephalothorax, each carrying a pair of dichotomously branched processes, one in the middle and the other near the base on the ventral side.

*Length.*—5.8 mm.

*Host.*—Carangid.

*Distribution.*—Sri Lanka.

*Remarks.*—According to Kirtisinghe this species is closest to *T longimana* Wilson from which it differs in the more slender and longer processes which are branched only once and not twice as in *T longimana.*

### **Thysanote heterodactyla** Kirtisinghe

*Thysanote heterodactyla* Kirtisinghe, 1964, p. 116, figs. 166-168 ; Pillai, 1967d, p. 1659, fig. 244.

*Female.*—Cephalothorax short, dorso-ventrally flattened and slightly inclined downwards. Cephalon somewhat enlarged, with distinct carapace. Trunk short, cylindrical and much longer than cephalothorax. Its posterior part with a conical process and a pair of unbranched diverging processes. Postero-lateral parts with three pairs of unbranched processes, one ventral, one lateral and

one dorsal, ventral processes much longer than the others. Egg sacs more than twice as long as the ventro-lateral trunk processes.

Maxillae nearly as long as cephalothorax, each with a pair of dichotomously branched long slender processes near base (it can also be a single process branched twice as described by Kirtisinghe) and a single shorter unbranched process in the middle of the ventral side.

*Length.*—6.6 mm.

*Host.*—*Carangoides armatus.*

*Distribution.*—Sri Lanka.

*Remarks.*—This species closely resembles *T furcata* but the branching of the processes is different. From available information *T furcata* and *T heterodactyla* show some resemblance to *T longmana* Wilson. These three species are parasitic on carangid fishes in the same locality. In view of the fact that the branching of the body processes of *T longimana* varies the validity of the above described two species should be reexamined. I could not secure the specimens for study.

### **Thysanote rastrelligeri** Rangnekar

*Thysanote rastrelligeri* Rangnekar, 1961, p. 200, fig. 4 ; Pillai, 1967d, p. 1659, fig. 242.

*Female.*—Cephalothorax slender, about twice as long as trunk. Head slightly swollen. Trunk broadest at the hind end, its distal border convex, with a pair of median unbranched processes. Postero-lateral parts of trunk with two pairs of unbranched processes, ventro-lateral ones longer than the dorso-lateral, all curving inwards.

Antennule three-jointed, third segment with three short spiniform setae. Antenna biramous, rami two-jointed, exopod broader, terminal segment of endopod with two minute spines. Maxillule slender, with two long setiform spines, palp with two short spines. Maxillae nearly as long as trunk, free but "jointed at a distance

about two-thirds from base and again at the tips", each carrying a basal and a median ventral unbranched process. Maxilliped close to the mouth, its basal segment much enlarged "with its outer and distal margins carrying a broad transparent frill", terminal segment with an outer large spine and an inner feebler spine, inner margin behind the spine dentate.

*Length.*—8.0 mm.

*Host.—Rastrelliger kanagurta.*

*Distribution.*—India (Bombay).

*Remarks.*—The unusually long cephalothorax and the number and nature of the body processes distinguish this species. Rangnekar has stated that the maxillae are fused at two-thirds length from base and further on free. This is not likely to be true. She has also stated that the maxilliped carries a broad transparent frill. This obviously is the chitinous covering of the body and some of the appendages usually present in lernaeopodids.

This comparatively large copepod is reported to infest the gill filaments. It may be so. But usually species of *Thysanote* are attached to the gill arches and not the filaments.

**Thysanote eleutheronemi** Rangnekar
(Fig. 263)

*Thysanote eleutheronemi* Rangnekar, 1961, p 202, fig. 5 ; Pillai, 1967d, p. 1659, fig. 241.
*Thysanote octofimbriata* Tripathi, 1962b, p. 225, figs. 27-32.
*Thysanote decemfimbriata* Pillai, 1962d, p. 63, fig. 4.

*Female.*—Cephalothorax short, stout and somewhat dorsoventrally flattened, about one and a half times as long as broad. Carapace distinct. Trunk comparatively broad, rectangular and slightly longer than broad, the neck-like part connecting the two swollen at the place of insertion of the maxillae. Posterior process bilobed. Postero-median part of trunk with a pair of unbranched diverging processes, each postero-lateral corner of the trunk with two pairs of unbranched processes very much similar to the median processes. Egg sacs long.

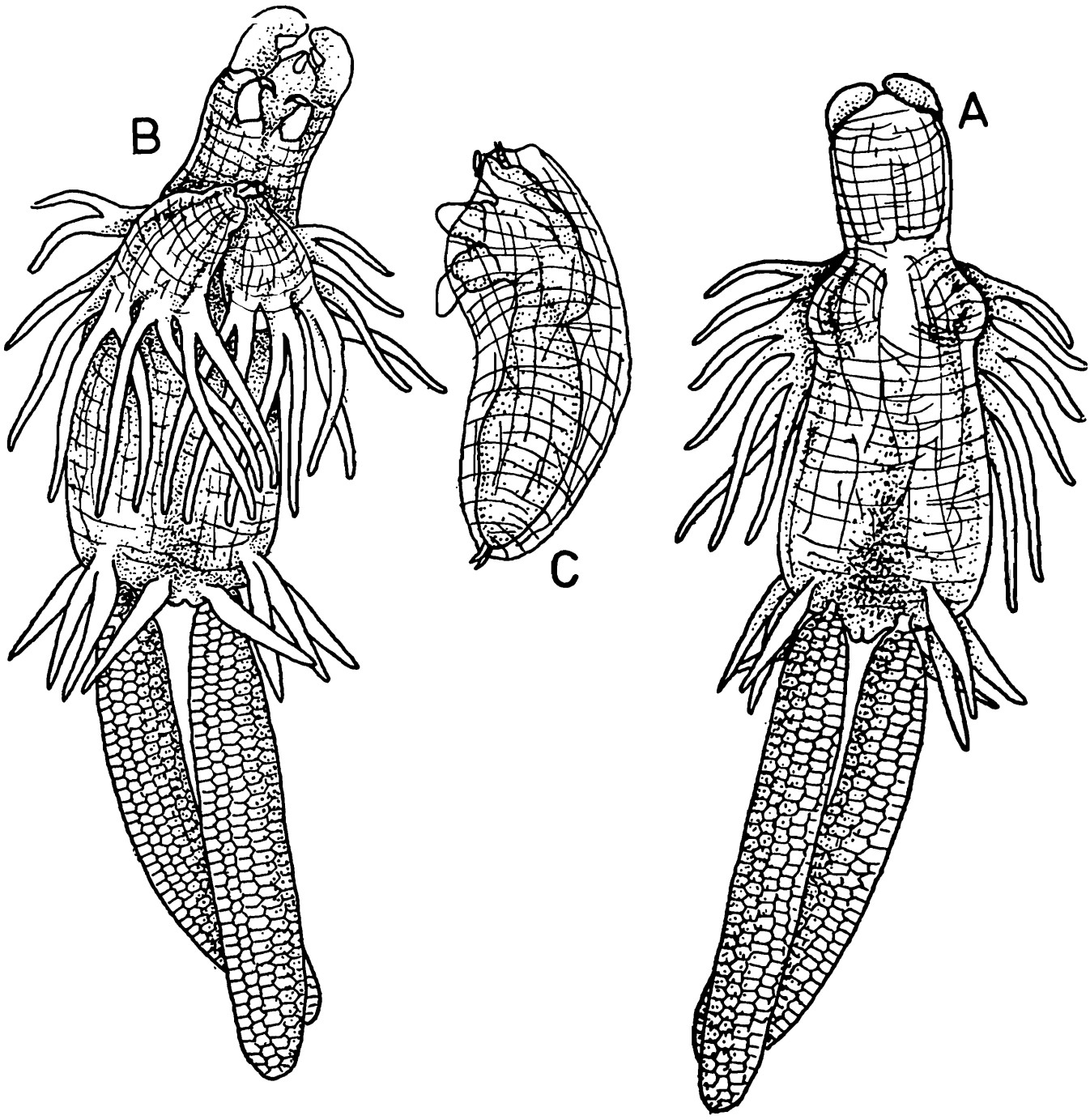


Fig. 263. *Thysanote eleutheronemi* Rangnekar : A, female, dorsal view ; B, same, ventral view ; C, male.

Antennule four-jointed, fourth segment with two setae and two spines. Antenna biramous, outer ramus with an accessory lobe and a spine, inner ramus two-jointed, distal segment with three spines. Mandible with twelve teeth. Maxillule with two apical spines and a prominent outer spiny bulge, palp with two spines. Maxillae short but stout, free, each carrying proximally four dichotomously branched processes. Bulla small and vine glass-shaped.

Basal segment of maxilliped with median inner spine placed on a prominence and a distal inner bulge, distal segment produced below the unguis into two spines, one sharp and the other blunt.

*Length.*—5.0 mm.

*Male.*—Cephalothorax and trunk demarcated by a narrow waist. Carapace distinct. Trunk oblong or elliptic. Caudal rami present. Antennule as in female. Outer lobe of antenna with one spine, distal segment of inner ramus with a spiny crest, a short spine and a long spine. Maxillule as in female, without the outer bulge on the stem. Maxillae and maxillipeds two-jointed and subchelate.

*Length.*—1.0 mm.

*Host.—Eleutheronema tetradactylum, Polynemus plebeius.*

*Distribution.*—India (Bombay, Calcutta, Kerala).

*Remarks.*—In *T eleutheronemi* the trunk has one median and two lateral processes and each maxilla carries four dichotomously branched processes. The same is the case in *T octofimbriata* Tripathi. There is therefore no doubt that *T octofimbriata* is a synonym of *T eleutheronemi.*

In *T decemfimbriata* each maxilla has five dichotomously branched processes and the trunk carries postero-laterally only three processes, one dorsal and two ventral. This is the condition in the two specimens I had. In view of the fact that slight variation in the number and branching of the processes is not unusual in *Thysanote* and as all the three species parasitise the same host in the same locality I consider them as synonymous.

## Genus **Pseudocharopinus** Kabata

*Diagnosis.*—Cephalothorax long and cylindrical, about two-thirds as long as trunk. Head clearly demarcated, enlarged, with distinct carapace. Maxillae free, longer or slightly shorter than cephalothorax. Maxilliped well developed, close to the mouth tube. Trunk slightly flattened dorsoventrally, longer than or as

long as broad, with a short anterior neck. Posterior processes, two, in some species vestigial, dorsal to egg sacs.

Parasites of elasmobranchs.

Type species.—*P. dentatus* (Wilson).

*Discussion*—Kabata (1964c) divided the then composite genus *Charopinus* into five genera, divisible into two groups depending on the length and nature of inclination of the cephalothorax in relation to the trunk. *Charopinus* and *Pseudocharopinus* have long cephalothorax inclined over the trunk while *Schistobranchia*, *Dendrapta* and *Charopinopsis* have short ventrally inclined cephalothorax. *Charopinus* differs from *Pseudocharopinus* in the presence of a distinct carapace, antennae with heavily sclerotised base, well developed maxillipeds placed close to the mouth cone, button-shaped sclerotised bulla and in the mandibular formula.

Under *Pseudocharopinus* Kabata placed six species, *P. dentatus*, *P. bicaudatus*, *P. malleus P. markewitschii*, *P. concavus* and *P. squali.* To these must be added two more species, *P. dasyaticus* (Pillai 1962d) and *P. narciniae* (Pillai 1962d). Of the eight known species only three occur in Indian waters.

According to Kirtisinghe (1964) *P. dasyaticus* (Pillai) and *Clavellopsis dasyaticus* Rangnekar are synonyms of *P. markewitschii* (Gussev). This view was opposed by Kabata (1968a). He upheld the validity of *P. dasyaticus* (Pillai). Kabata expressed the opinion that if *Clavellopsis dasyaticus* proves to be a *Pseudocharopinus* as suggested by Kirtisinghe Pillai's species will have to be given a new name since Rangnekar's species will have priority. I have in my collection a single female of Rangnekar's species and am in a position to confirm that it is a *Pseudocharopinus.* I, therefore, rename *P. dasyaticus* (Pillai) as *P. kabatai.*

*Key to species of* **Pseudocharopinus**

| | |
|---|---|
| 1. Maxillae as long as or longer than cephalothorax, trunk longer than both | *narcinal* (Pillai) |
| — Maxillae shorter than cephalothorax | .2 |
| 2. Trunk clearly longer than broad | .*kabatai* new name |
| — Trunk nearly equal in length and width | *dasyatious* (Rangnekar) |

## **Pseudocharopinus narcinae** (Pillai)
(Fig. 264)

*Charopinus narcinae* Pillai, 1962d, p. 68, fig. 7.
*Pseudocharopinus narcinae* Pillai, 1967d, p. 1661, fig. 247.

*Female*.—Cephalothorax long and stout, cephalic part covered by a carapace. Trunk very long, longer than cephalothorax,

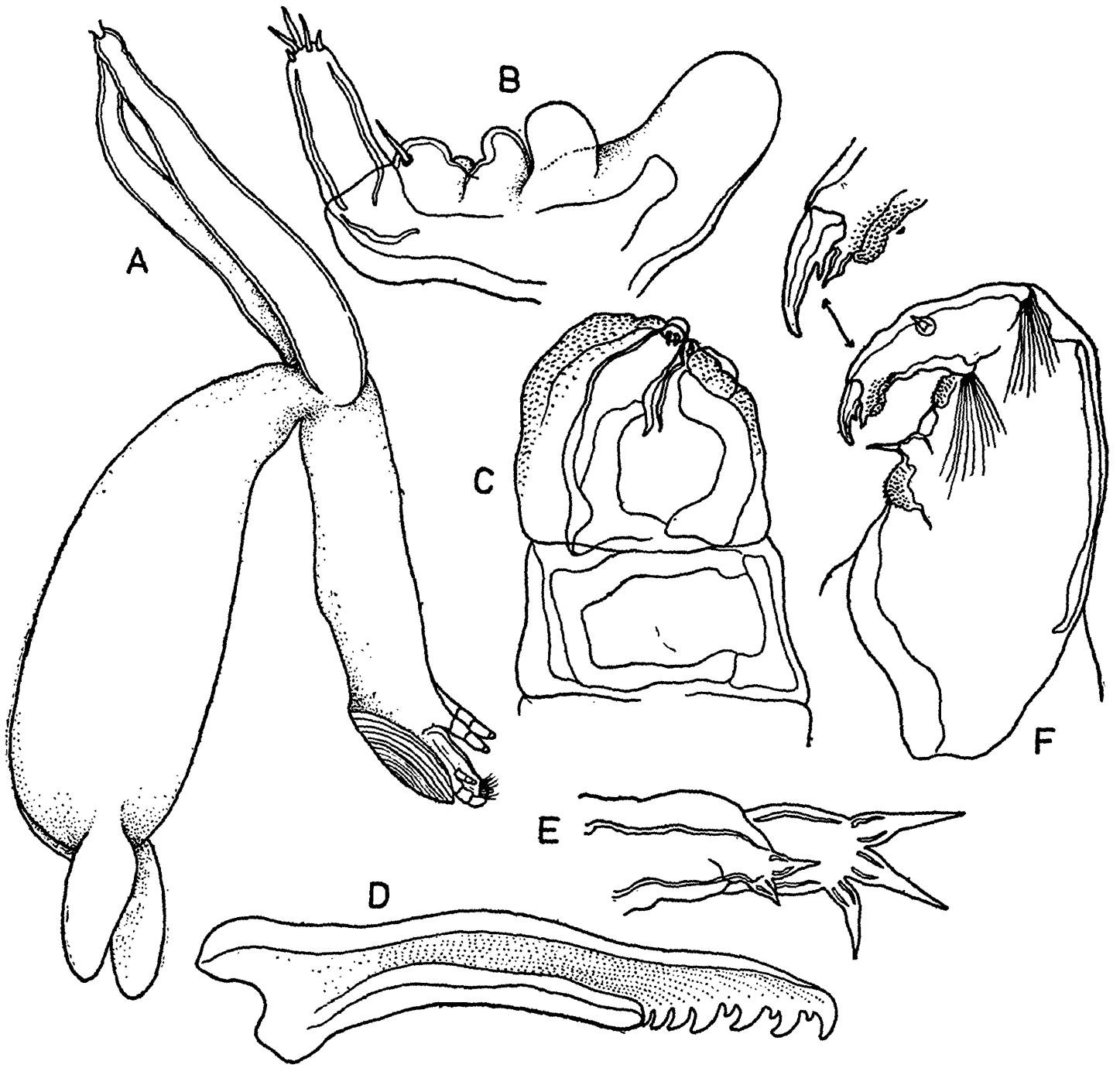


Fig. 264. *Pseudocharopinus narcinae* (Pillai) : A, female, lateral view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxilliped.

posterriorly bilobed, with indications of a genital process. Trunk processes large, oblong and apically rounded.

Antennule apparently two-jointed, basal segment enlarged and flattened, with four lobes, first lobe large, fourth carrying a large spine, second segment two and a half times as long as broad, with an apical bunch of four spines and a seta. Both lobes of antenna with spiny surface, outer with two and inner with one apical spines. Mandible with a double curve, distally narrowed and cut into seven large teeth, first three alternating with small teeth, fourth primary tooth largest. Maxillule short but stout, with two large spines and a smaller spine, palp small, with two short broad-based spines. Maxillae very long, as long as cephalothorax, completely free and apically not enlarged into semicircular lobes, bulla boat-shaped. Maxilliped stout, basal segment with a median spine having a spiny bulge on both sides, distal segment strong and irregular in outline, with a median spine, lower border proximal to the unguis bulged and spiny, terminating in a strong spine, unguis with a ventral tooth.

*Length.*—10.7 mm.

*Host.—Narcine timlei.*

*Distribution.*—India (Kerala).

*Type* in the National Zoological Collection at Zoologica Survey of India, Calcutta.

**Pseudocharopinus kabatai** new name
(Fig. 265)

*Charopinus dasyaticus* Pillai, 1962d, p. 66, fig. 6.
*Charopinus markewitschi* Kirtisinghe 1964, p. 118, figs. 170, 177-179 (in part) (nec Gussev 1951).
*Pseudocharopinus dasyaticus* Pillat, 1967d, p. 1660, fig. 246; Kabata, 1968a, p. 576, figs. 1 A-C.

*Female.*—Cephalothorax strongly bent backwards, cephalic portion broader and nearly half the length of cephalothorax. Carapace present. Trunk with short anterior neck-like part, further

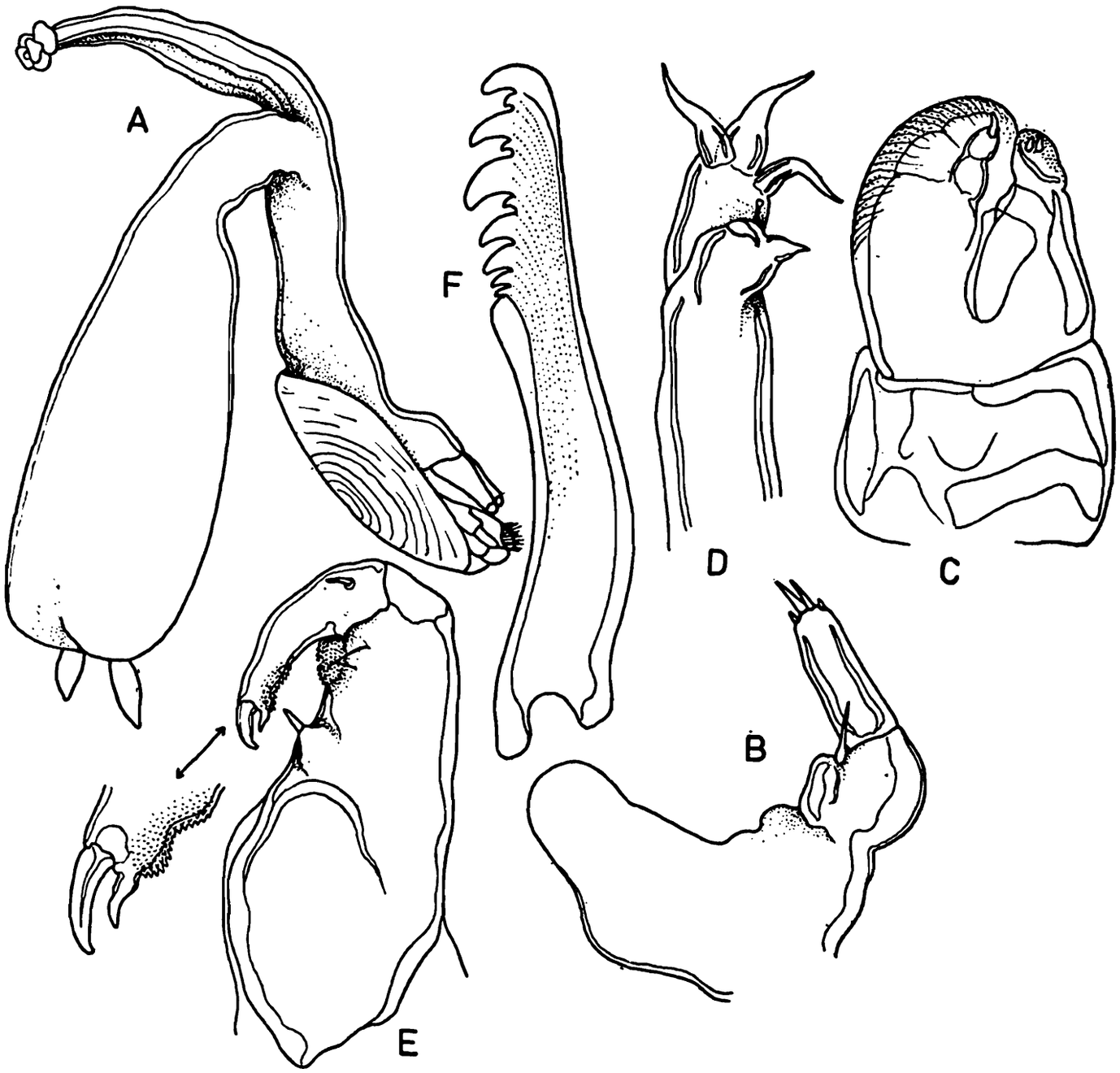


Fig. 265. *Pseudocharopinus kabatai* (Pillai): A, female, lateral view; B, antennule ; C, antenna ; D, maxillule ; E, maxilliped ; F, mandible.

on broadening, posterior border bilobed. Ganital lobe small and bilobed. Trunk processes oblong or elliptic, apically acute.

Antennule three-jointed, basal segment enlarged into an irregular lamina, second segment short but broad, with a long inner seta, third segment long, apically armed with two short and two long spines. Outer lobe of antenna indistinctly two-jointed, with one

apical spine, inner lobe two-jointed, distal segment with two apical spines, surface of both lobes spiny and wrinkled. Mandible with double curve, with seven primary teeth, first three successively increasing in size and alternating with three subsidiary teeth, others successively decreasing in size. Maxillule robust, apically armed with three large processes, median process stout, palp broad, with two short processes. Maxillae free, apically enlarged into semicircular lobes, about half as long as trunk, bulla cup-shaped. Basal segment of maxilliped comparatively long and slender, inner distal part with a sharp spine and a bulge carrying small denticles, distal segment stumpy and irregular, with basal spine, lower distal patch of denticles and a blunt spine, unguis short but stout.

*Length.*—6.1 mm.

*Male.*—Body clearly segmented. Cephalothorax large and broad, with large carapace. Trunk narrow. Antennule three-segmented, second segment with one seta, third with a seta, a spine and a club-shaped process. Outer lobe of antenna large and smooth, inner two-jointed, distal segment with a strong distal spine, inner distal part produced. Maxillule with three subsimilar apical spines, palp with one spine. Maxilla subchelate, distal segment folding against a spiny lobe on basal segment. Maxilliped three-jointed, basal segment long, placed at right angles to second, latter distally produced into a hollowed lobe into which the third segment fits, fourth trunk segment with a pair of digitiform processes. Caudal rami long and apically acute, with two outer setae.

*Length.*—1.8 mm.

*Host.*—*Dasyatis imbricatus; D.fluviorun, D, uarnac, Aetomylaeus nichofii.*

*Distribution.*—India (Kerala), Sri Lanka, Queensland.

*Types* in National Zoological Collection, Z.S.I., Calcutta, Reg. No. C2166/2 & C2167/2.

*Remarks.*—Though Kirtisinghe made *C. dasyaticus* Pillai and *Clavellopsis dasyaticus* Rangnekar synonyms of *P. markewitschi*

(Gussev) Kabata upheld the validity of *C. dasyaticus* on the ground that *P. markewitschi* lacks foliaceous lobe on the antennule.

Pillai (1962d) pointed out the similarity between *P. markewitschi* and *P. dasyaticus* following the suggestion by Shiino (1956b, 1959c). Since then I have been able to consult Capart's (1946) paper. As observed by Kabata Capart did not provide enough details for comparison. But the character of the male, the structure of the female mandibles and the maxillule indicate that they might be synonymous. The final decision can be made only after deciding whether the antennule of *P. markewitschi* has a basal lobe.

**Pseudocharopinus dasyaticus** (Rangnekar)
(Fig. 266)

*Clavellopsis dasyaticus* Rangnekar, 1957a, p. 16, fig. 5.
*Charopinus markewitschi* Kirtisinghe, 1964, p. 118, fig. 177 (in part).

*Female.*—Cephalothorax fairly stout, longer than trunk and maxillae, divisible into a stout cephalon and a narrower cylindrical neck. Cephalic part with a small, indistinct carapace. Trunk slightly longer than broad, not appreciably narrowed in front, but with a very short neck, somewhat dorso-ventrally flattened and with a shallow dorsal longitudinal groove. Postero-median lobe very small. Trunk processes small, narrow, apically drawnout. Egg sacs slender, as long as maxillae.

Antennule three-jointed, basal segment a four to five-lobed lamina with an inner spine on the last lobe. second and third segments, subequal in length, latter with two setae, a stout long spine and two short spines , this appendage more closely resembles that of *P. narcinae* rather than of *P. kabatai.* Antenna rather slender, distally bilobed, outer lobe larger, with one outer and one inner or ventral stout spine, inner lobe with two spines, surface of both lobes with patches of spinules. Maxillae longer than trunk, shorter than cephalothorax, completely free. Bulla missing in the one specimen examined. Each maxilla distally enlarged into a semicircular lobe. Basal segment of maxilliped conical, with inner median spine, distal segment short, produced below the unguis, its basal part with a blunt spine.

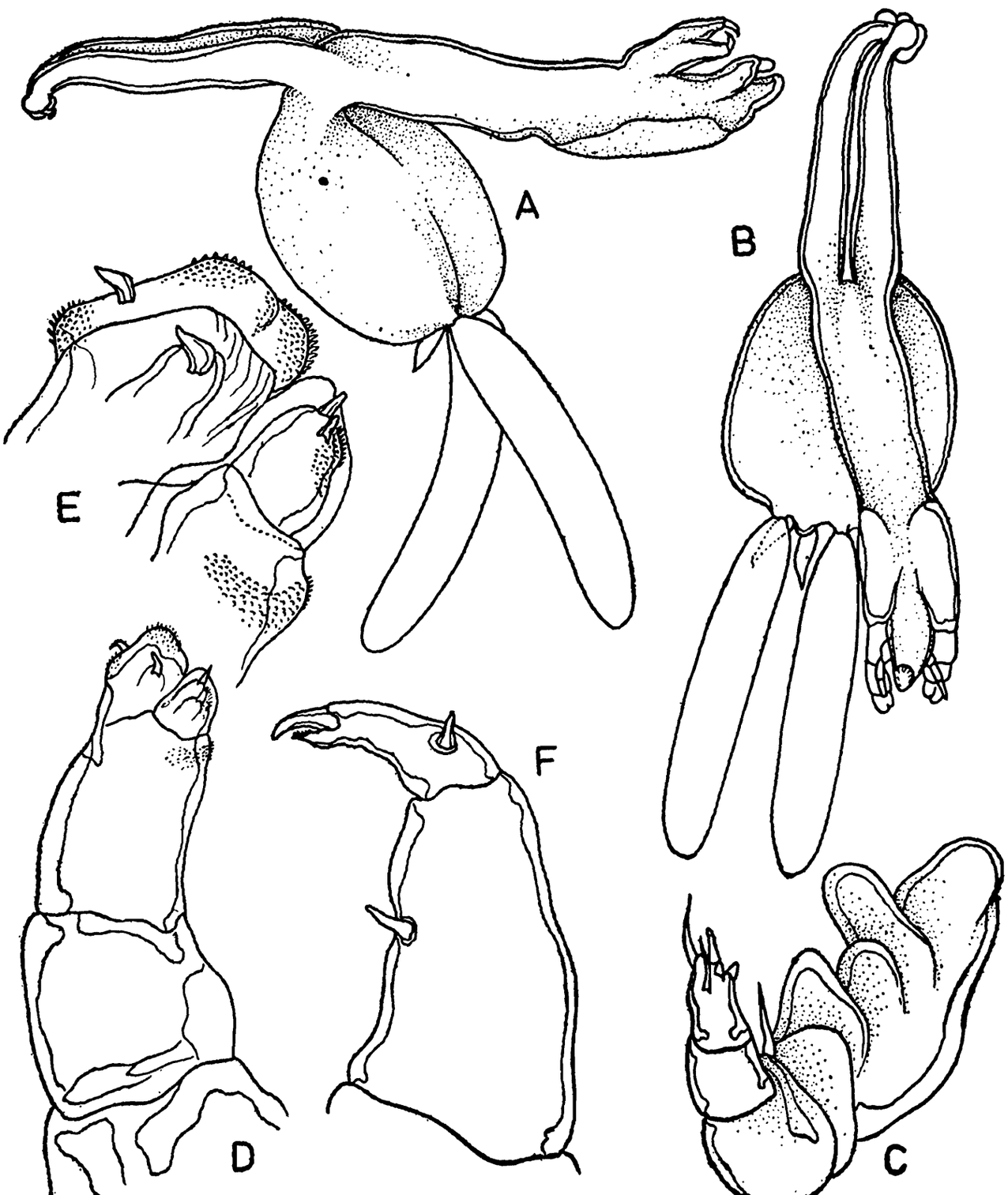


Fig. 266. *Pseudocharopinus dasyaticus* (Rangnekar) : A, female, lateral view ; B, same, ventral view, trunk dorsal ; C, antennule ; D, antenna ; E, same tip enlarged ; F, maxilliped.

*Length.*—4.9 mm.

*Host.*—*Dasyatis uarnac, Aetomylaeus nichofii, Aetobatos* sp.

*Distribution.*—India (Bombay, Kerala). Sri Lanka.

*Remarks.*—As I had only one specimen I did not attempt to study the appendages. It is not known whether a type specimen is preserved by Rangnekar.

Compared to my specimen the maxillae of Rangnekar's specimen are very short. Rangnekar has mentioned about conspicuous elliptical lobes projecting through the bases of the antennae. These are obviously the lobes of the antennule characteristic of *Pseudocharopinus.* Her illustration of the entire animal is such that the trunk appears pyriform. It is roughly squarish, slightly longer than broad. What she has described as caudal rami are the trunk processes.

This species is a typical *Pseudocharopinus* easily distinguishable from the others by the shape of the trunk. Hence Kirtisinghe is not correct in making it a synonym of *P. markewitschi.*

## Genus **Charopinopsis** Yamaguti

*Charopinopsis* Yamaguti, 1963, p. 250 ; Kabata, 1964c, p. 164.

*Diagnosis.*—Cephalothorax of medium length, cylindrical, not clearly demarcated from trunk, either in line with the trunk or inclined backwards at right angles to the long axis of the latter. Trunk elongated, with two pairs of posterior processes ventral to egg sacs. Maxillae free, fused to a small bulla.

Parasites of teleosts.

Type species.—*C. quaternia* (Wilson).

*Discussion.*—Unlike the other genera which formerly formed the genus *Charopinus, Charopinopsis* is not well characterised. Kabata placed in this genus *C. quaternia* (Wilson) and *C. albida*

(Rangnekar). These two species however have practically nothing in common. It is also significant that all the other species which formed the old genus *Charopinus* are parasites of elasmobranchs whereas species of *Charopinopsis* parasitise teleosts.

Kabata was aware of the anomalous position of *Charopinopsis*. He observed that its maxillule is like that of higher lernaeopodids and the antenna like that of *Lernaeopoda*. He concluded that "of all the species placed in the old genus *Charopinus* those now belonging to *Charopinopsis* were deposited there with least justification" *C. albida* as shown earlier (Pillai 1962d) is a *Brachiella*. I am of opinion that *C. quaternia* can also be shifted to *Brachiella*. The description of its male by Wilson (1935a) is not very helpful in making a decision.

**Charopinopsis quaternia** (Wilson)
(Fig. 267)

*Charopinus quaternia* Wilson, 1935a, p. 343, pl. 4, figs. 42-49.
*Brachiella coryphaenae* Pearse, 1952, p. 35, figs. 129-135 ; Pillai, 1962d, p. 85, fig. 18 ; Yamaguti, 1963, p. 248, pl. 270, fig. 7.
*Charopinopsis quaternia* Kabata, 1964c, p. 104, figs. 91-100 ; Pillai, 1967d, p. 1661, fig. 256 ; Lewis, 1967, p. 171, fig. 65.

*Female.*—Cephalothorax roughly cylindrical, very short compared to the trunk. Trunk composed of an anterior necklike part and a broad, long, dorso-ventrally flattened posterior portion, latter postero-laterally produced into apically acute short processes Postero-median part produced into a small bilobed process and a pair of long flattened trunk processes, six to seven times as long as the lateral processes, always bent outwards.

Antennule small and highly swollen, four-segmented, fourth segment armed with three apical and one subapical spine. Antenna bilobed, outer lobe large, appearing as a mere prolongation of the stem, inner lobe projecting as some sort of an appendix, clearly two-jointed, distal segment with two apical spines, both lobes with spiny surface. Mandible apically narrowed, with eight primary teeth, first three alternating with secondary teeth. Maxillule with outer distal semicircular bulge, apex with a short outer and two longer stout inner spines, palp small, with two slender

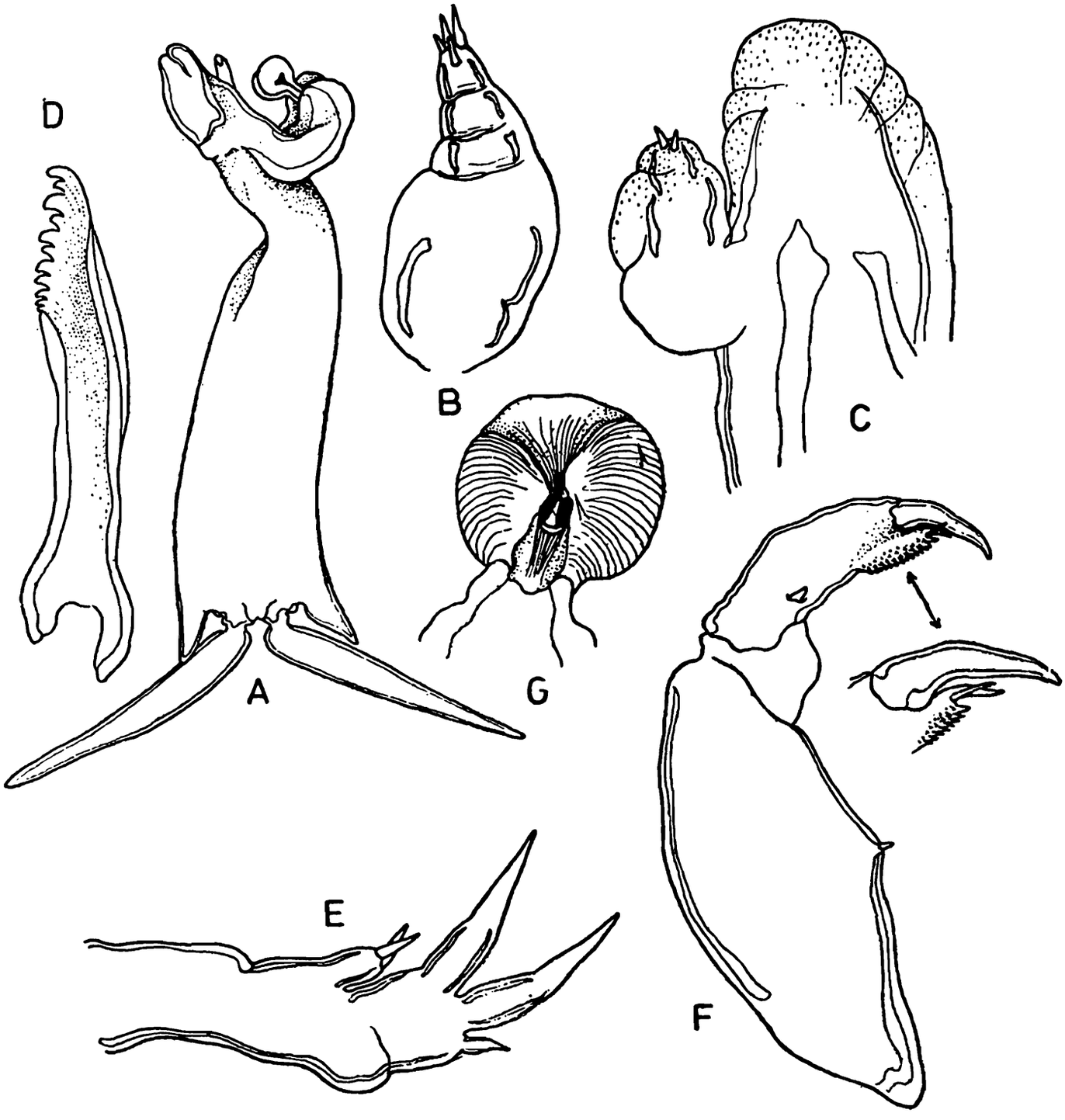


Fig. 267. *Charopinopsis quaternia* (Wilson) : A, female, dorsal view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxiliped ; G, tip of maxilla.

spines. Maxillae long, stout and flattened, fully free, apically enlarged into nearly circular lobes holding between them a deeply sunk small bulla. Maxilliped slender, basal segment long elliptic, produced at inner median part and carrying a short blunt spine,

distal segment stout, with a long curved unguis, below the unguis the segment forms a serrate and spiny crest ending in two long spines.

*Length.*—5.4 mm.

*Host.—Pristidion gracilis, Coryphaena hippurus, Scomberomorus cavalla.*

*Distribution.*—Gulf of Mexico, Texas, Hawaii, India (Kerala).

## Genus **Brachiella** Cuvier

*Brachiella* ; Wilson, 1915, p. 698 ; 1932, p. 520 ; Barnard, 1955, p. 296 ; Yamaguti, 1963, p. 246.

*Diagnosis.*—Cephalothorax long and cylindrical, usually curved over the dorsal side of the trunk. Head slightly enlarged, with distinct carapace. Trunk swollen, dorso-ventrally flattened, with small genital process and two or four trunk processes. Abdomen and caudal rami absent. Maxillae generally free, bulla vine glass-shaped.

Male with cephalothorax demarcated from trunk by a deep sinus, carapace present. Trunk with indications of segmentation. Caudal rami present.

Parasites of teleosts.

Type species.—*B. thynni* Cuvier.

*Discussion.*—The following species have been recorded from Indian waters :—*B. albida* (Rangnekar), *B. lutiani* (Pillai) new name, *B. trichiuri* Gnanamuthu, *B. thynni* Cuvier, *B. merlucii* Bassett-Smith, *B. gulosa* Wilson, B. *otolithi* Pillai and *B. indica* Tripathi. *B. indica* Tripathi is a synonym of *B. albida* (Rangnekar). Kirtisinghe (1950) recorded *B. gulosa* from the buccal cavity of *Trichiurus savala* but later (Kirtisinghe, 1964) treated it as *B. trichiuri* Gnanamuthu. On the authority of Thompson and Scott (1903) Kirtisinghe included *B. merlucii* in the Ceylon fauna. As this record is doubtful I am omitting it from the present work.

*Key to species of* **Brachiella**

| | | |
|---|---|---|
| 1. | Dorsal trunk processes as long as ventral | *.otolithi* Pillai |
| — | Dorsal trunk processes longer than ventral . | .2 |
| 2. | Ventral trunk processes less than half the length of the dorsal | *albida* (Rangnekar) |
| — | Ventral trunk processes more than half the length of the dorsal processes | .3 |
| 3. | Trunk indistinctly segmented | *.thynni* Cuvier |
| — | Trunk not segmented | .4 |
| 4. | Trunk with two pairs of processes | *.trichiuri* Gnanamuthu |
| — | Trunk with three pairs of processes | *lutiani* (Pillai) new nam |

## **Brachiella albida** (Rangnekar)
(Fig. 268)

*Charopinus albidus* Rangnekar, 1956, p. 62, figs ; Yamaguti, 1963, p. 252.
*Brachiella indica* Tripathi, 1962b, p. 223, figs. 17-24 (nec Pillai, 1968d).
*Brachiella albida* Pillai, 1962d, p. 86, fig. 19 ; 1967, p. 1666, fig. 260.
*Charopinopsis albida* Kabata, 1964c, p. 106.

*Female.*—Cephalothorax much shorter than trunk, fairly stout. Cephalon somewhat swollen, with indistinct carapace. Trunk gradually widening backwards. Posterior part of trunk with two pairs of processes, dorso-lateral ones about three times as long as the ventro-median, both narrowing distalwards. Genital process prominent and bilobed.

Antennule four-segmented, second segment with an inner tubercle, fourth with two long and two short spines. Outer lobe of antenna unarmed, inner two-jointed, distal segment with two spines. Distal part of mandible narrow and cut into nine primary teeth, first two alternating with subsidiary teeth. Maxillule with two long distal spines, palp with one spine. Maxillae stout, free, bulla rod-shaped, distally flared. Maxilliped large, basal segment with inner median projection carrying a small spine, distal segment partially fused with basal, unguis slender, long and curved, lower border of the segment near base of the unguis serrated but not forming a crest, ending in a small and a large spine.

*Length.*—3.0 mm.

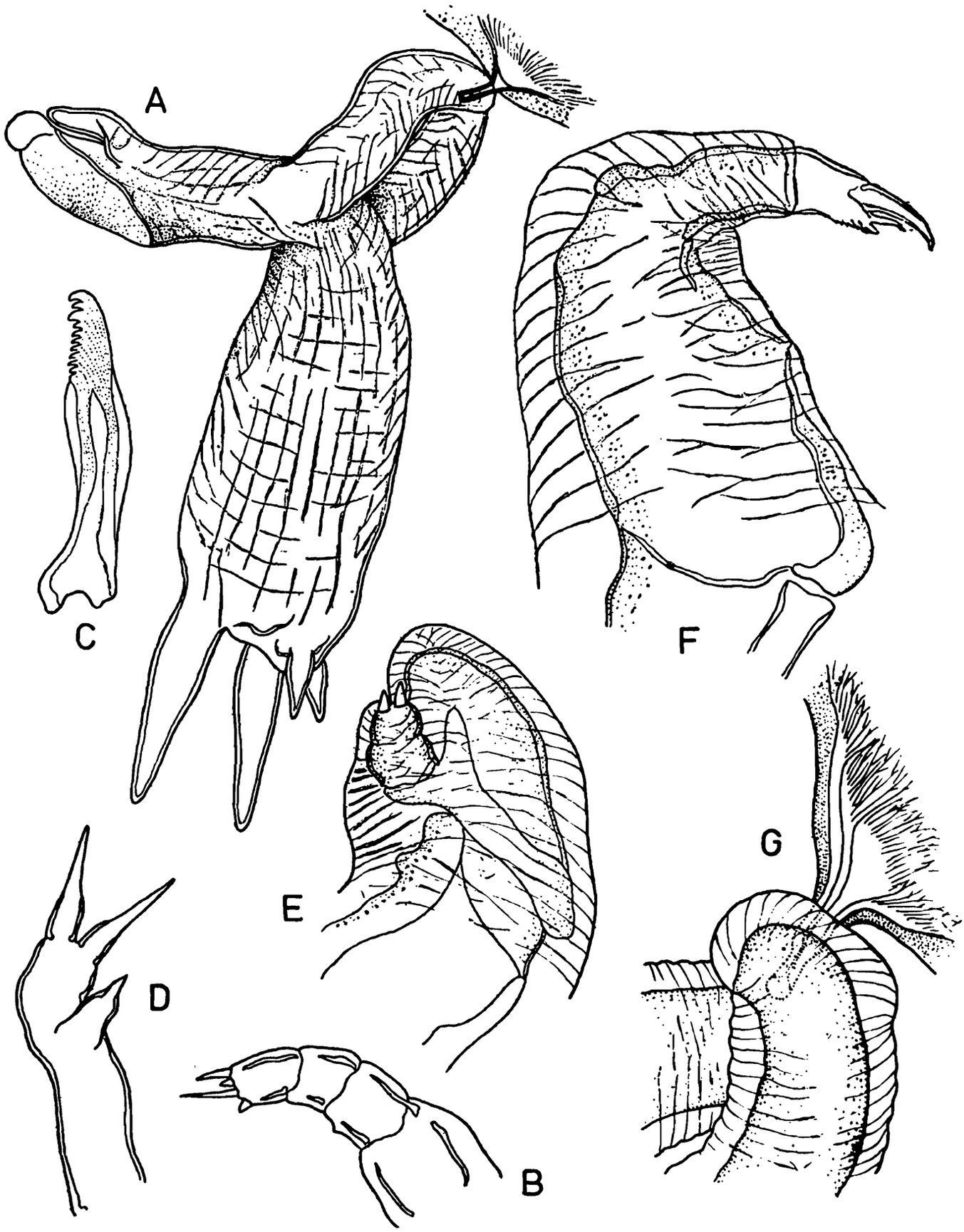


Fig. 268. *Brachiella albida* (Rangnekar) : A, female, lateral view ; B, antennule ; C, mandible ; D, maxillule ; E, antenna ; F, maxilliped ; G, tip of maxilla.

*Male.*—Cephalon with distinct carapace. Cephalothorax demarcated from trunk by a prominent waist, the whole body covered by a wrinkled chitinous envelop. Caudal rami long, with one proximal inner spine, one outer distal spine and two apical setae.

Antennule four-segmented, with one small and three long apical spines. Antenna with unarmed outer lobe, inner lobe two-segmented and overreaching the outer by the length of its distal segment, latter with a distinct unguis and an inner spine. Maxillule with two apical spines, palp with a short spine.

*Length.*—0.2 mm.

*Host.*—*Sciaena glaucus, Otolithus argenteus, Pseudosciaena albida.*

*Distribution.*—India (Bombay, Kerala, Orissa).

*Remarks.*—*B. indica* Tripathi is undoubtedly a synonym of *B. albida* (Rangnekar) but it appears that in Tripathi's specimen the dorsal trunk processes are shorter. He has described the antennule as three-segmented but his figure shows four constrictions. Tripathi's description of the distal segment of the maxilliped is incorrect.

Rangnekar has described the ventral trunk processes as dorsal but correctly illustrated them. She has figured two small caudal rami which are not present. Contrary to Rangnekar accessory teeth alternate with only the first two primary teeth. The palp of the maxillule has only one spine, not two. Rangnekar has stated that each maxilla carries its own attachment process and that there is no bulla. Evidently the bulla was lost while removing the specimen.

## **Brachiella trichiuri** Gnanamuthu
(Fig. 269)

*Brachiella trichiuri* Gnanamuthu, 1951e, p. 13, fig. 1 ; Pillai, 1962d, p. 83, fig. 17 ; 1967d, p. 1666, fig. 257 ; 1968d, p. 119, figs. 1-2 ; Yamaguti, 1963, p. 249.
*Brachiella gulosa* Kirtisinghe, 1950, p. 84 (nec Wilson, 1915).
*Clavellopsis trichiuri* Kirtisinghe, 1964, p. 121, figs. 175-176.

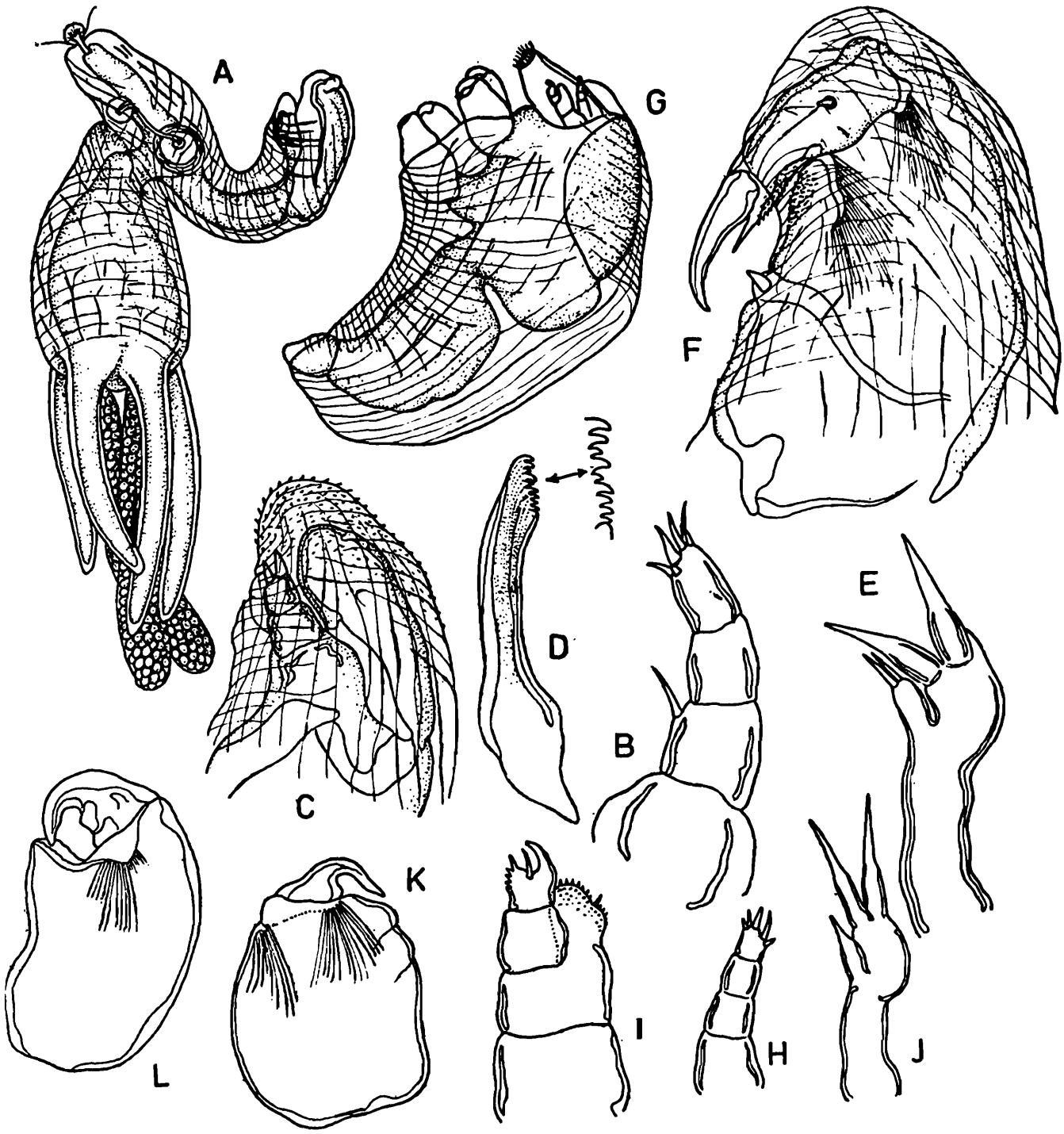


Fig. 269. *Brachiella trichiuri* Gnanamuthu : A, female, lateral view; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxilliped; G, male ; H, antennule ; I, antenna ; J, maxillule ; K, maxilla ; K, maxilliped.

*Female.*—Cephalothorax curved into a semicircle, cephalic part enlarged, with carapace. Trunk pyriform, as long as cephalothorax, the whole body covered by a loose chitinous envelope. Hind part of trunk with two pairs of long cylindrical processes, dorsal processes longer than ventral. Genital lobe rounded.

Antennule comparatively stout and four-segmented, first segment swollen, second with a stout spine, fourth segment with five spines and one seta, one of the spines very short, two long. Exopod of antenna large, with spiny surface, endopod two to three-segmented, distal segment armed with two unequal apical spines. Mandible comparatively small and slender, curving inwards, distal border oblique and cut into seven primary teeth, third from tip largest, second and third alternating with subsidiary teeth. Maxillule swollen at the outer distal part, with two large spines, palp fairly large, with two short spines, Maxillae fused into a stout cylindrical process, bulla mushroom-shaped. Maxilliped robust, inner middle part of basal segment with a short spine, inner distal part covered with blunt tubercles, distal segment with basal spine, distal lower part spiny and prolonged into a sharp spine, unguis strong and well curved.

*Length.*—3.3 mm.

*Male.*—Cephalothorax broad, trunk dorsally bulging, the two demarcated by a deep sinus. Carapace distinct. Caudal rami large and laminate. Antennule four-segmented, fourth segment with three short and two long apical spines. Exopod of antenna laminate, with spiny surface and an outer median large spine, endopod two-jointed, distal segment ending in a strong claw carrying a setiform spine near its base, inner distal part forming a serrate crest. Distal part of maxillule swollen, with two long slender spines, palp with one spine. Maxilla and maxilliped subchelate, former shorter but stouter, with a slender curved claw, latter with stout claw curving against a cup-shaped lobe on the basal segment.

*Length.*—0.5 mm.

*Host.*—*Trichiurus haumela, T savala.*

*Distribution.*—India (Madras, Kerala), Sri Lanka.

*Remarks.*—The creation of *Isobranchia* by Heegaard produced some confusion regarding this species. Kirtisinghe (1964) considered *B. trichiuri* as a synonym of *Clavellopsis trichiuri* Yamaguti. On the other hand Yamaguti (1963) transferred his species to *Isobranchia.*

But *Isobranchia* has *Clavella* type of male while *C. trichiuri* Yamaguti has *Brachiella* type of male. Hence *C. trichiuri* should be placed in *Brachiella* and not *Isobranchia*. Contrary to Kirtisinghe *C. trichiuri* Yamaguti is quite different from *B. trichiuri* Gnanamuthu in having an elongated genital process (rounded in *B. trichiuri* Gnanamuthu). In Yamaguti's species the dorsal trunk processes are shorter than the ventral, just the reverse in the other. If *C. trichiuri* turns out to be a true *Brachiella* Gnanamuthu's species will have to be given a new name. The confusion cannot be cleared until we have clear definitions of *Brachiella*, *Clavellopsis* and *Isobranchia* which are not available so far.

## **Brachiella thynni** Cuvier
(Fig. 270)

*Brachiella thynni* Stp. & Lutk., 1861, p. 420, pl. 15, fig. 36 ; Heller, 1868, p. 34 ; Brian, 1906, p. 105, pl. 9, fig. 1 ; Scott, T & A, 1913, p. 703, pl. 25, fig. C, pl. 53, figs. 209-215 ; Kirtisinghe, 1935, p. 342, figs. 40-41 ; 1964, p. 119, figs. 171-172 ; Shiino, 1956b, p. 283, figs. 8-9 ; Pillai, 1962d, p. 81, figs. 15-16 ; Yamaguti, 1963, p. 247, pl. 271, fig. 1 ; Lewis, 1967, p. 174, figs. 66-67.

*Female.*—Body demarcated into a short cephalothorax and a broad segmented trunk. Carapace indistinct. Trunk with two pairs of posterior processes, dorsal pair about two and a half times as long as ventral, proximally transverse and distally slightly enlarged, making it club-shaped, ventral processes directed straight backwards. A low bilobed genital lobe present.

Antennule highly swollen, three-jointed, basal segment very large, fourth with four apical and one subapical teeth. Outer lobe of antenna large, inner small and two-jointed, placed at right angles to the outer, distal segment with three spines. Mandible with eight primary teeth, first four large, others small, second and third alternating with subsidiary teeth. Maxillule stout, with three large distal processes, inner very stout, palp with a very small spine. Maxillae moderately long, free, narrowing towards the bulla, bulla vine glass-shaped. Basal segment of maxilliped with two tubercles and a patch of spinules, distal segment stout, unguis apically blunt and not clearly demarcated, lower border close to the unguis spiny and terminating in a short spine.

Fig. 270. *Brachiella thynni* Cuvier : A, female, dorsal view ; B, same, ventral view ; C, antennule ; D, antenna ; E, mandible ; F, maxillule ; G, maxilliped ; H, male ; I, antennule ; J, antenna ; K, maxillule ; L, maxilliped; M, maxilla.

*Length.*—8.7 mm.

*Male.*—Body demarcated into cephalothorax and trunk by a distinct waist. Carapace not evident. Trunk elliptic, ventrally demarcated into five segments. Caudal rami present.

Antennule stout but short, three-segmented, first segment with one inner spine, third with two inner and four distal spines. Outer lobe of antenna with two spines, inner lobe two-jointed, distal segment with three spines. Moxillule with three distal processes, palp with one. Maxilla with stout basal segment, distal segment a broad based irregularly curved claw. Basal segment of maxilliped long and cylindrical, inner border with four spiny lobes and a spine, distal segment more or less fused with basal, with median lower spine and distal spiny bulge, unguis short and curved.

*Length.*—1.4 mm.

*Host.—Indocybium lineolatum, Thunnus thynnus, T macropterus, Orcynus thynnus, Sciaena aquila, S. umbra, Scomberomorus cavalla, Pomatomus saltatrix, Acanthocybium solandri, Chirocentrus dorab.*

*Distribution.*—India (Kerala), Sri Lanka, Adriatic, Mediterranean, Belgium, England, Gulf of Mexico, Japan, Hawaii.

*Remarks.*—This species was described in detail by Shiino and Lewis. They have shown the trunk processes as long and subequal in length. In my specimens the processes are very dissimilar and rather short. The cephalothorax is also shorter and stouter.

*B. thynni*, though the type species, is an atypical member of the genus.

**Brachiella lutiani** Pillai new name
(Fig. 271)

*Brachiella indica* Pillai, 1968d, p. 123, figs. 3-6 (nec Tripathi 1962b).

*Female.*—Cephalothorax bent over the trunk, curved into a semicircle. Cephalon enlarged, with distinct carapace. Trunk

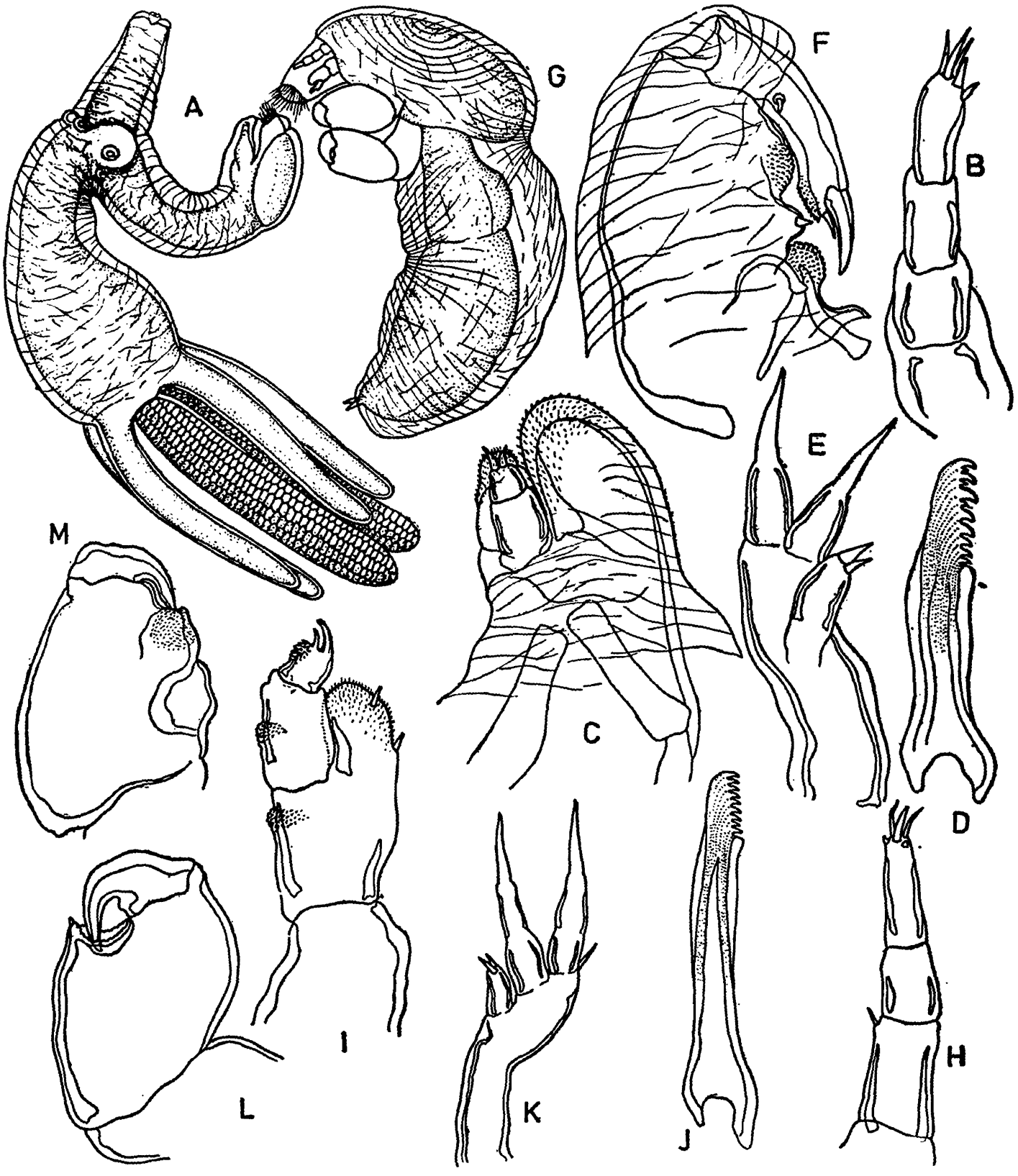


Fig. 271. *Brachiella lutiani* (Pillai) : A, female, lateral view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxilliped ; G, male ; H, antennule ; I, antenna ; J, mandible ; K, maxillule ; L, maxilliped ; M, maxilla.

longer than cephalothorax, widening backwards, postero-median part produced into a faintly bilobed genital process attached to which is a pair of irregular processes. Trunk processes two pairs, long and digitiform, nearly equal in length, ventral ones placed closer to each other.

Antennule four-jointed, fourth segment with five apical spines. Outer lobe of antenna with even borders, surface distally spiny, inner lobe two-jointed, distal segment with two spines, apical part of the lobe spiny. Toothed portion of mandible narrow, with eight primary teeth, third tooth largest, first three alternating with subsidiary teeth. Maxillule with stout stem, apex with two stout processes, palp with two small spines. Maxillae moderately long, completely fused, bulla small and sunk into the maxillae. Basal segment of maxilliped with large inner median boss carrying a spine and a tuberculated boss on either side, distal segment unusually long, with basal spine and distal lower serrate crest ending in a long spine, unguis stout, only slightly curved.

*Length.*—5.0 mm.

*Male.*—Cephalothorax demarcated from trunk by a narrow waist, carapace indistinct. Trunk elongated and indistinctly three-segmented. Caudal rami small and triangular.

Antennule long and three-jointed, first segment with inner distal spine, third with three spines and two tubercles. Basipod of antenna with inner spiny bulge, exopod short and spinulose, with two marginal spines, endopod two-jointed, each segment with a spiny bulge, distal segment overreaching exopod and with two claw-like spines. Maxillule ending in two exceptionally large processes and a small outer spine, palp with two very small spines. Mandible slender, with nine subsimilar primary teeth, no subsidiary teeth. Basal segment of maxilla with inner distal cup-like expansion with crenate edge, claw stout. Basal segment of maxilliped with inner distal spiny bulge, claw moderately curved.

*Length.*—1.1 mm.

*Host.*—*Lutianus* sp.

*Type.* In National Zoological Collection at Z.S.I. Calcutta. Reg. No. C2168/2.

*Remarks.*—As the name *indica* is preoccupied I propose the new name *lutiani.*

This species closely resembles *B. trichiuri* Gnanamuthu but differs in minor details of the appendages. More over the female of *B. lutiani* has a third pair of trunk processes and the cephalothorax of its male is different in shape.

**Brachiella otolithi** Pillai
(Fig. 272)

*Brachiella otolithi* Pillai, 1962d, p. 89, fig. 20 ; 1967d, p. 1667, fig. 258.

*Female.*—Cephalothorax long and slender, flexed backwards nearly at right angles to trunk, more or less straight, cephalic part slightly enlarged, carapace indistinct. Trunk triangular, longer than broad, with large cylindrical genital process. Trunk processes two pairs, ventral pair on either side of the genital process, slightly longer than the dorsal, latter placed wide apart, dorsolateral in position. Maxillae fused, distally forming semicircular lobes, bulla small, vine glass-shaped. Egg sacs comparatively large.

*Length.*—4.0 mm.

*Male.*—Cephalothorax large, with distinct carapace, trunk slender, waist demarcating the two not prominent. Body covered by a very loose covering.

*Length.*—0.3 mm.

*Host.—Otolithus argenteus.*

*Distribution.*—India (Kerala).

*Type.* In National Zoological Collection at Z.S.I. Calcutta. Reg. No. C2169/2.

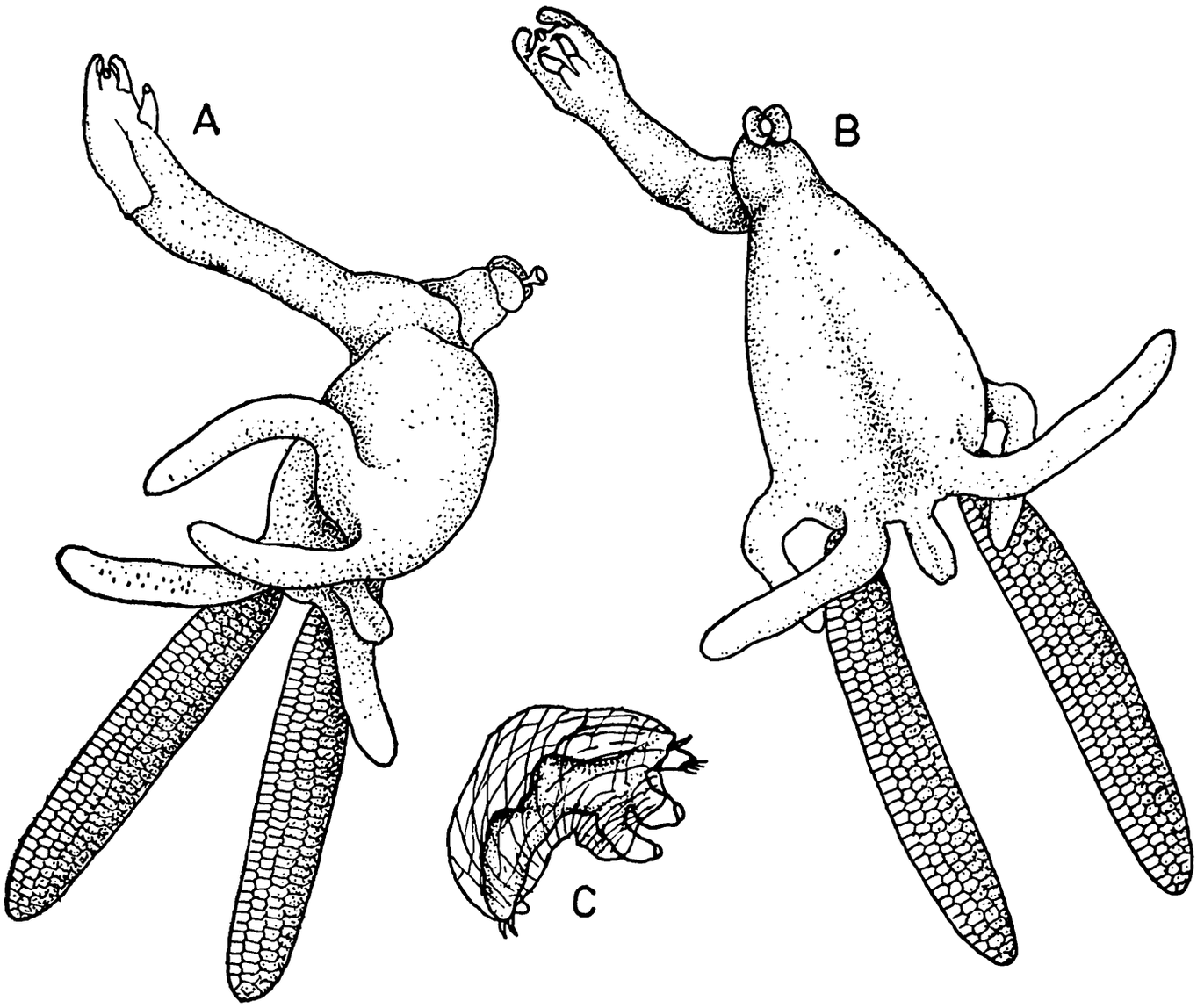


Fig. 272. *Brachiella otolithi* Pillai : A, female, lateral view ; B, same, ventral view ; C, male.

## Genus **Clavellisa** Wilson

*Clavellisa* Wilson, 1915, p. 693 ; Yamaguti, 1963, p. 253.

*Diagnosis.*—Cephalothorax much longer than trunk, attached to the middle of the dorsal side of latter. Head slightly enlarged, with carapace. Trunk generally broader than long, dorso-ventrally flattened. No genital or abdominal process. Vestigial legs or caudal rami often present. Antennule well armed with spines and setae. Antenna biramous, rami highly chitinised and flexed at right angles to stem. Maxillae short, free or fused, bulla small. Maxilliped of the usual type.

Cephalothorax of male completely fused with trunk, latter may or may not have a pair of caudal rami. Carapace present.

Parasites of marine teleosts.

Type species.—*C. spinosa* Wilson

*Discussion.*—According to Wilson *Clavellisa* has no genital, abdominal or trunk processes and caudal rami. But vestigial structures are present at the postero-median part of the trunk, probably in all species.

Eight species have so far been recorded from Indian waters. *C. emarginata* recorded by Pillai (1962d) is the same as *C. obchordata* Rangnekar (1957), *C. ilishae* Pillai (1962d) the same as *C. hilsae* Tripathi (1962b) and *C. chordata* recorded by Pillai (1962d) the same as *C. pellonae* Tripathi (1962b). Regarding priority no firm decision can be taken until the actual date of publication of the works of Pillai and Tripathi is ascertained.

*Key to species of* **Clavellisa**

| | | |
|---|---|---|
| 1. | Cephalothorax about three times as long as trunk, trunk definitely broader than long | .2 |
| — | Cephalothorax about two times as long as trunk, trunk nearly as broad as long | .4 |
| 2. | Egg sacs long and cylindrical | *obchordata* Rangnekar |
| — | Egg sacs circular or ovoid | .3 |
| 3. | Trunk twice as broad as long | *dussumieriae* Gnanamuthu |
| — | Trunk less than twice as broad as long | *hilsae* Tripathi |
| 4. | Maxillae free | *pellonae* Tripathi |
| — | Maxillae fused | *phasa* Tripathi |

## **Clavellisa obchordata** Rangnekar
(Fig. 273)

*Clavellisa obchordata* Rangnekar, 1957, p. 17, figs. 6, 7a.
*Clavellisa emarginata* Pillai, 1962d, p. 74, fig. 11 (nec Kroyer 1837).

*Female.*—Cephalothorax long and slender, nearly twice as long as trunk. Cephalon slightly enlarged, with distinct carapace. Trunk

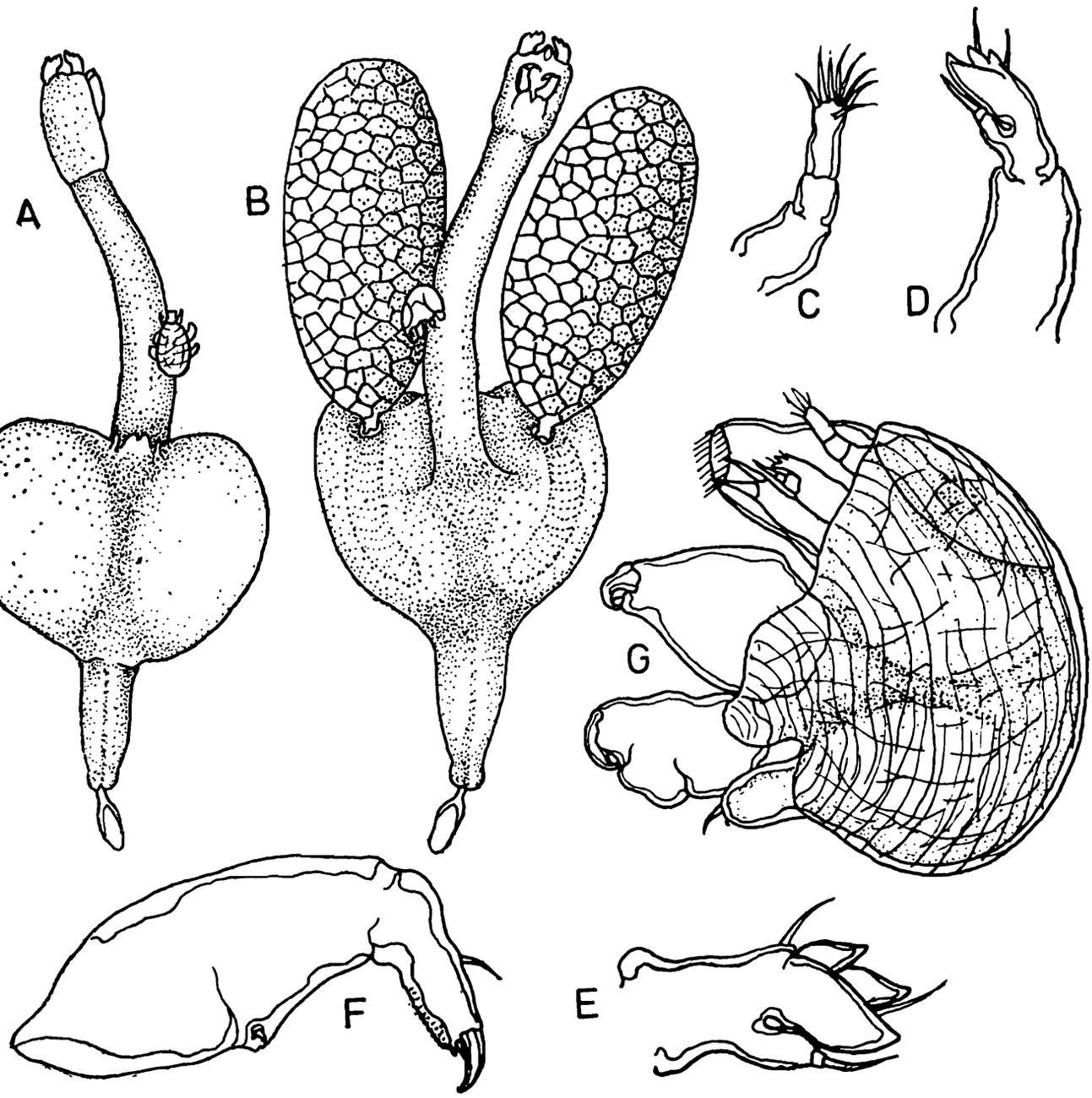


Fig. 273. *Clavellisa obchordata* (Rangnekar) : A, female, cephalothorax dorsal, trunk ventral ; B, same, cephalothorax ventral, trunk dorsal ; C, antennule ; D, antenna ; E, same enlarged ; F, maxilliped ; G, male.

pyriform, slightly broader than long, ventral side with median longitudinal groove making the surface bilobed, hind border with median bilobed genital process or abdomen and a pair of tubercles carrying a spine. Egg sacs oblong, slightly longer than trunk.

Antennule three-segmented, third setment with six long setae and two blunt spines. Antenna highly chitinised, distal part bent

inwards, exopod large, three lobed, carrying two spine-like setae, endopod small, two-jointed, with long apical spine. Maxillae comparatively long, completely fused, apically slightly bulging. Basal segment of maxilliped large, with inner median spine, distal segment partially fused with basal, with outer spine, lower distal part spiny, ending in two spines, unguis short but well curved.

*Length.*—3.0 mm.

*Male.*—Body hemispherical. Cephalothorax and trunk completely fused but demarcated by a groove. Carapace distinct. Caudal rami large, each carrying a spine.

*Length.*—0.3 mm.

*Host.*—*Thrissocles malabaricus Chatoessus nasus.*

*Distribution.*—India (Bombay, Kerala).

*Remarks.*—In Rangnekar's specimen the cephalothorax, maxillae and egg sacs are comparatively longer than in mine and according to her the bulla is absent. This obviously is a mistake. Her description of the antenna is faulty. It is therefore with some reservation that I identify my collection as *C. obchordata.* This species shows some resemblance to *C. emarginata.*

## **Clavellisa dussumieriae** Gnanamuthu
(Fig. 274)

*Clavellisa dussumieriae* Gnanamuthu, 1947a, p. 748, figs. 1-7 ; Pillai, 1962d p. 76, fig. 12 ; Yamaguti, 1963, p. 254.

*Female.*—Cephalothorax very long and vermiform, originating from the middle of the dorsal side of the trunk. Cephalon slightly swollen. Carapace distinct. Trunk transversely oblong, nearly twice as broad as long. Genital lobe conical and apically incised. Egg sacs originating from dorsal side of trunk, large and globular, with a small number of large eggs.

Antennule apparently four-segmented, fourth segment with a bunch of three spines and four setae. Antenna with large sympod,

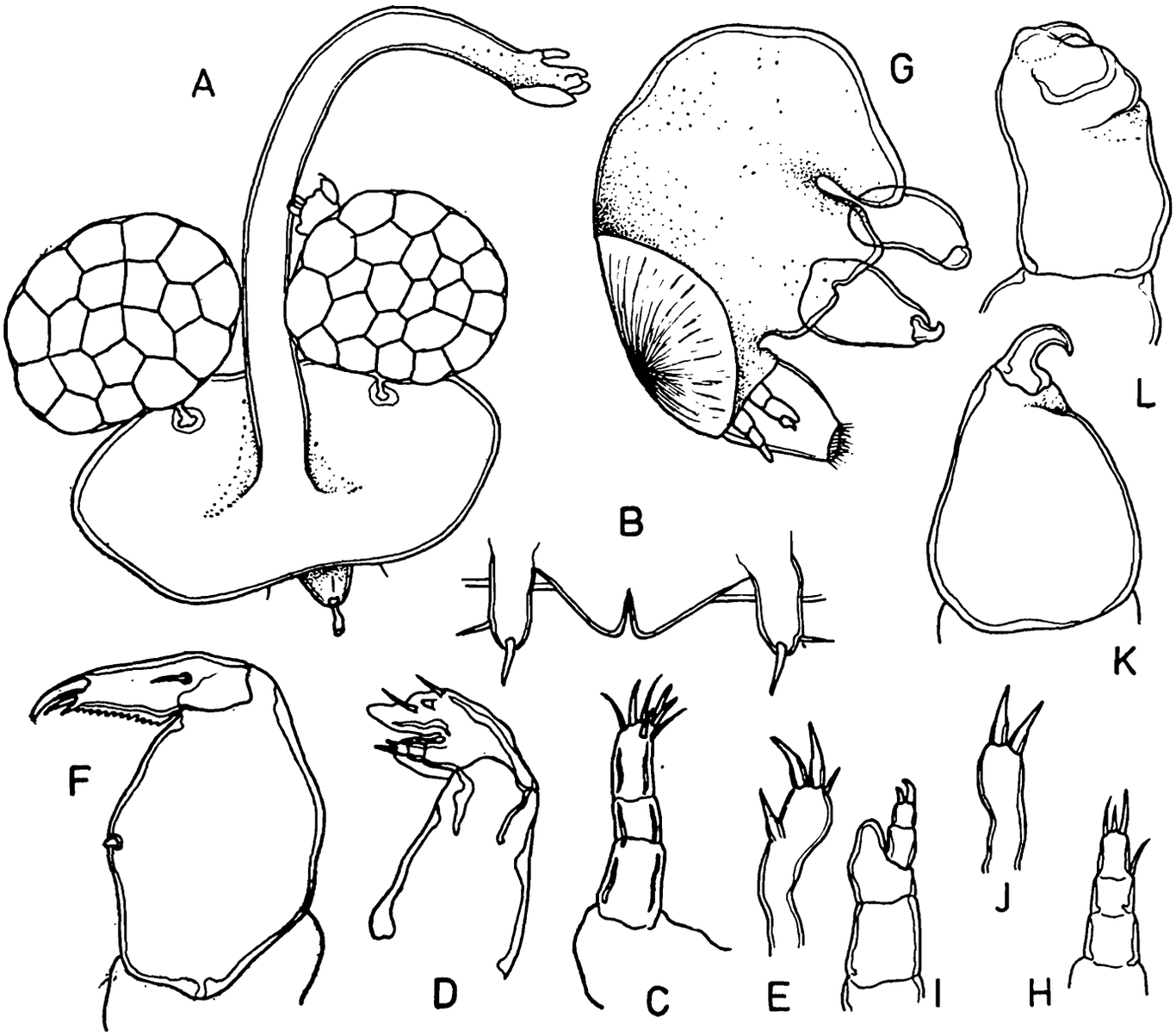


Fig. 274. *Clavellisa dussumieria* Gnanamuthu : A, female : B, hind part of trunk ; C, antennule ; D, antenna ; E, maxillule ; F, maxilliped ; G, male ; H, antennule ; I, antenna ; J, maxillule ; K, maxilla ; L, maxilliped.

distal part bent at right angles to basal, outer lobe (exopod) with a tooth and two spines, endopod three-jointed, terminal segment with two spines. Mandible with two large and two small teeth. Maxillule with two distal and one outer spine, palp short, with one spine. Maxillae very short, fused into a conical lobe carrying a vine glass-shaped bulla, submarginal ventral in position. On either side of the maxillae there is a setule mounted on a tubercle. Basal segment of maxilliped stout, elliptic, with inner median spine, distal segment nearly straight, fairly stout, with a proximal spine, the

whole of its ventral border serrate, ending in a short and a long spine, unguis apically curved. On either side of the genital process is a cylindrical process carrying a distal and an outer seta.

*Length.*—3.0 mm.

*Male.*—Body roughly oval, with large carapace and fairly large caudal lobe, trunk deep. Antennule four-jointed, third segment with one seta, fourth with three spine-like setae. Outer lobe of antenna short and unarmed, inner two-jointed, with two apical claws. Maxillule distally enlarged, with two spines, palp not observed. Basal segment of maxilla conical, distal small, strongly curved. Maxilliped cylindrical, distal segment a very small claw.

*Length.*—0.3 mm.

*Host.—Dussumieria acuta, D. hasselti.*

*Distribution.*—India (Madras, Kerala).

## **Clavellisa hilsae** Tripathi
(Fig. 275)

*Clavellisa hilsae* Tripathi, 1962b, p. 218, figs. 1-5.
*Clavellisa ilishae* Pillai, 1962d, p. 79, fig. 14.

*Female.*—Cephalothorax long and slender, about three times as long as trunk, head slightly swollen, carapace indistinct. Trunk laterally expanded, about one and a half times as broad as long. Postero-median part of trunk with bilobed genital process, each lobe with an apical spine. Anterior border of trunk with a pair of setules on either side of the maxillae.

Antennule three-segmented, segmentation indistinct, third segment with apical bunch of three setae and three spines. Distal part of antenna bent inwards, indistinctly bilobed, exopod with one spine, endopod two-jointed, with one spine. Mandible with two large and two small teeth. Maxillule distally swollen, with three fairly large distal processes, palp with two small spines. Maxillae fused into a short rounded lobe, bulla large and vine glass-shaped. Basal

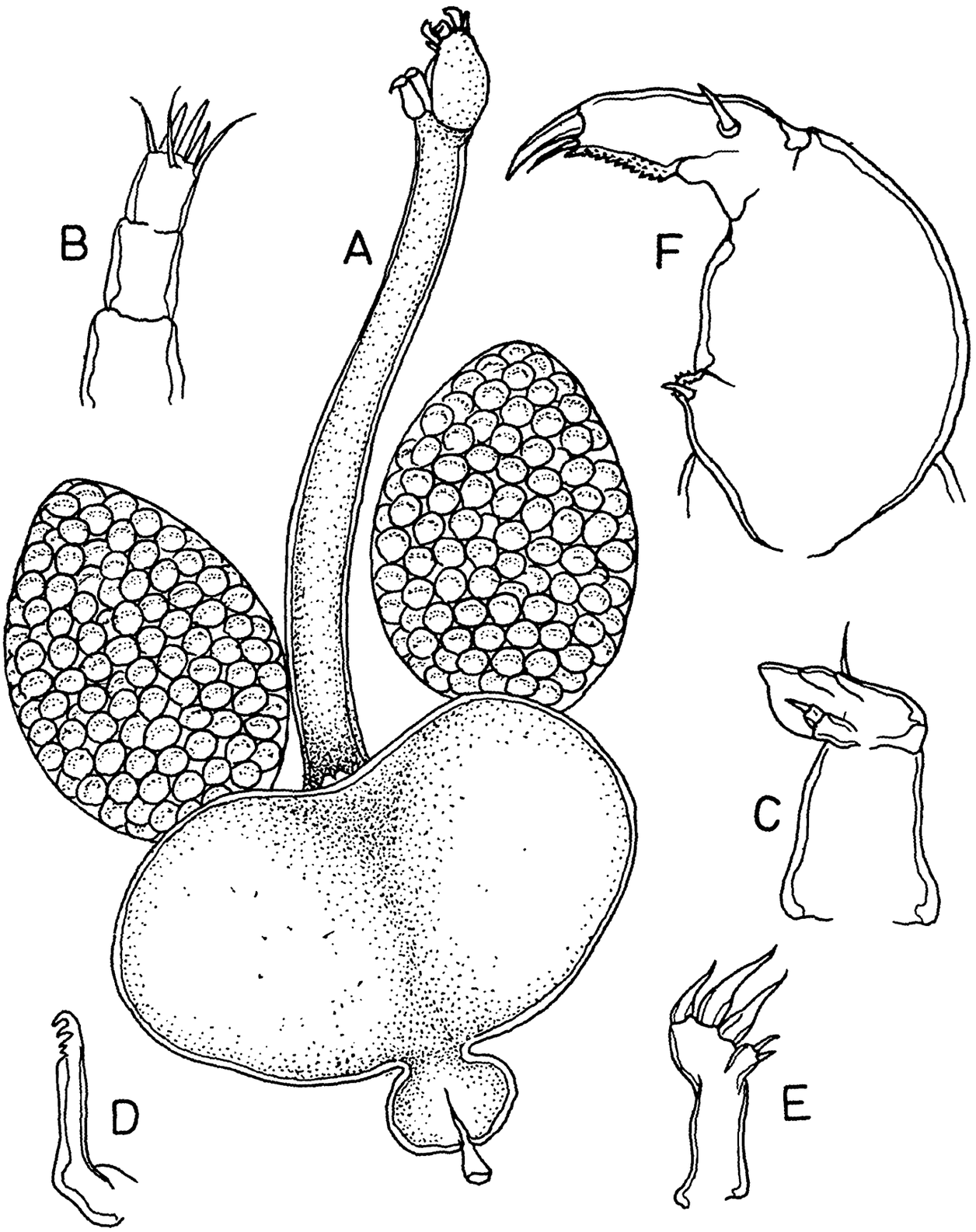


Fig. 275. *Clavellisa hilsae* Tripathi : A, female, ventral view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, maxilliped.

segment of maxilliped with proximal inner spinulose bulge carrying a spine, distal segment with large proximal spine, lower distal part serrated and ending in two spines, unguis rather slender and straight. Egg sacs large, oval.

*Length.*—2.5 mm.

*Host.—Hilsa ilisha, Ilisha filigera, Euplatygaster indica.*

*Distribution.*—India (Hoogly estuary, Chilka lake, Trivandrum).

*Remarks.*—Tripathi described the exopod of the antenna as having six to seven setae but I could find only one or two. The endopod carries only one and not two spines. The exopod is unjointed and the endopod two-jointed. Tripathi described the maxillule as biramous which is misleading. However Tripathi's description of the caudal rami as carrying the posterior processes and the presence of three apical processes on the maxillule show the identity of the two collections.

### **Clavellisa pellonae** Tripathi
(Fig. 276)

*Clavellisa pellonae* Tripathi, 1962b, p. 220, figs. 6-10.
*Clavellisa chordata* Pillai, 1962d, p. 78, fig. 13.

*Female.*—Cephalothorax long and slender but comparatively stouter than in most other species, originating from the dorsal side of the trunk nearer to the hind end and remaining at right angles to it. Carapace distinct, its anterior border with two pairs of tubercles, each carrying a spinule. Trunk triangular, rather swollen, its hind border nearly straight, with submarginal ventromedian bilobed genital process with a small finger-shaped process carrying a spinule on either side. Egg sacs ovate, eggs rounded.

Antennule four-jointed, apical segment with two spines and three setae. Distal part of antenna bilobed and bent inwards at right angles to the base, exopod large, apparently three-jointed, second segment with one and third with two spines, endopod small, two-jointed, with two spines. Mandible distally enlarged, with five to

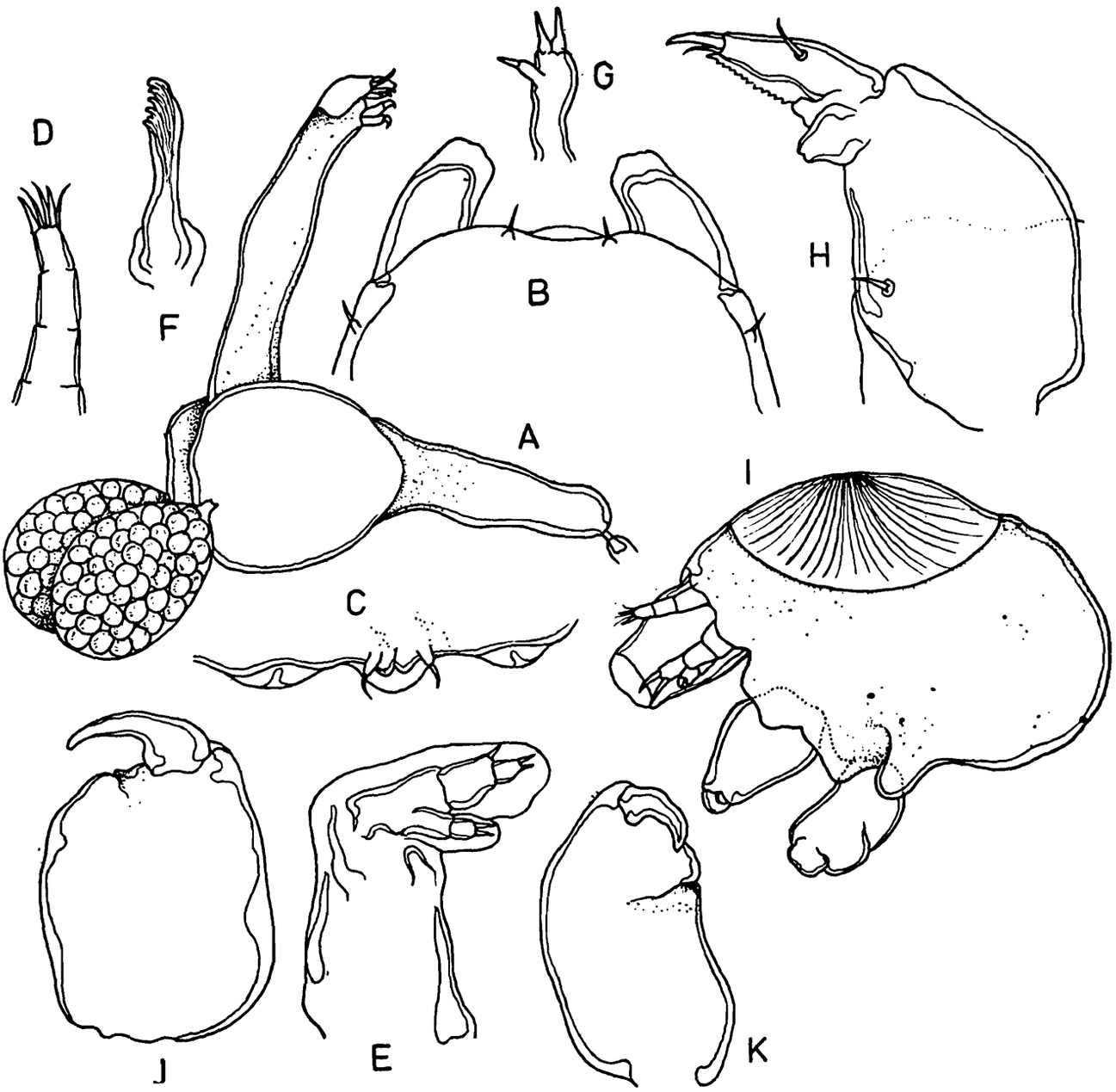


Fig. 276. *Clavellisa pellonae* Tripathi : A, female, lateral view ; B, anterior border of head ; C, posterior border of trunk ; D, antennule; E, antenna ; F, mandible ; G, maxillule ; H, maxilliped ; I, male ; J, maxillule ; K, maxilliped.

six teeth, secondary teeth not observed. Maxillule distally enlarged, with two processes, palp slender, with one spine. Maxillae comparatively very long, fully fused, bulla vine glass-shaped. Basal segment of maxilliped with proximal inner spine, its distal inner part produced into a conical lobe, distal segment broad, with a median spine, ventral border strongly serrated and ending in two spines, unguis short, slender and only slightly curved.

*Length.*—2.6 mm.

*Male.*—Body roughly ovate, with large caudal lobe. Carapace large and prominent. Antennule three-segmented, distal segment with four spines and one seta. Outer lobe of antenna with an outer tubercle, distal segment of inner lobe with two spines. Maxillule as in female. Maxilla with large roughly squarish basal segment, distal segment slender, long and curved beyond its base. Maxilliped with rectangular basal segment, distal segment rather stout, short and strongly curved.

*Length.*—0.3 mm.

*Host.*—*Ilisha* (*Pellona*) *indica.*

*Distribution.*—India (Hoogly estuary, Orissa, Kerala).

*Remarks.*—Contrary to Tripathi the last antennular segment carries three setae and two spines. The maxillules are uniramous, but carry two apical processes, but in this species the palp is shifted forwards, making the stem appear bifid. According to Tripathi the maxillae are fused at the tip. But in my specimens they are fully fused. In spite of these differences there is no doubt that the specimens I described as *C. chordata* belong to *C. pellonae* Tripathi.

## **Clavellisa phasa** Tripathi

*Clavellisa phasa* Tripathi, 1962b, p. 221, figs. 11-16.

*Female.*—Cephalothorax comparatively short, attached to posterior half of trunk. Trunk ovoid, nearly as long as broad. Egg sacs spherical to ovoid.

Antennule three-jointed, third segment with four setae. Exopod of antenna broad and apically cut into broad denticles, endopod two-jointed, second joint with two setae. Mandible with five teeth. Maxillule bipartite. Maxilliped two-jointed, basal segment large, with two proximal inner spines, second segment with two claws and a seta, ventral border serrated. Maxillae fused, cylindrical.

*Length.*—2.3 mm.

*Host.*—*Coilia dussumieri, Setipinna phasa.*

*Distribution.*—India (Hoogly, Malta).

*Remarks.*—The above description is from Tripathi. The available description of this species is inadequate. Mounting must have altered its real shape. C. *phasa* shows some resemblance to *C. pellonae* Tripathi, particularly to the specimens I previously described as *C. chordata.* It may be pointed out that Tripathi used the terms setae and spines indiscriminately. In the description of the antennae the exopod is described as endopod and vice versa, obviously following Wilson (1915).

## Genus **Isobranchia** Heegaard

*Diagnosis.*—Cephalothorax flexed backwards against the dorsal surface of trunk, rather short but stout. Carapace present. Trunk swollen, slightly flattened dorso-ventrally, rapidly widening backwards, with small genital process. Trunk with two pairs of long posterior processes, dorso-lateral and ventro-median, latter slightly shorter. Egg sacs stout, longer than trunk processes. Appendages clavelline.

Male clavelline.

Type species.—*I. appendiculata* Heegaard.

Parasites of teleosts.

*Discussion.*—In his definition of *Clavellopsis* Wilson (1915) observed that trunk processes are only rarely present. A careful study of *Clavellopsis* spp. shows that even when present they are small, quite different from those of *Isobranchia.* Hence my earlier observation (Pillai 1968) that *Isobranchia* is a synonym of *Clavellopsis* should be ignored.

In the nature of the trunk processes *Isobranchia* resembles a group of *Brachiella* spp. (see Yamaguti 1963) but unlike the latter has *Clavella* type of male.

Yamaguti transferred *Clavellopsis appendiculata* Kirtisinghe, *C. johnii* Yamaguti and *C. trichiuri* Yamaguti to *Isobranchia*. Of these *C. appendiculata* is a true *Isobranchia* but the others have *Brachiella* type of male and should come under *Brachiella*. This would necessitate the renaming of *B. trichiuri* Yamaguti since *B. trichiuri* Gnanamuthu has priority.

*I. appendiculata* Heegaard and *Clavellopsis appendiculata* Kirtisinghe are undoubtedly the same as shown earlier (Pillai, 1968). Hence *I. ceylonensis* Yamaguti (1963) becomes a synonym of *I. appendiculata* Heegaard.

The creation of *Isobranchia* and the consequent shifting of species clearly shows the confusion in our knowledge of the limits of at least some of the genera of Lernaeopodidae. I have found it rather difficult to assign some species to the proper genera.

## **Isobranchia appendiculata** Heegaard
(Fig. 277)

*Isobranchia appendiculata* Heegaard, 1947c, p. 241, figs. 1-4 ; Yamaguti, 1963, p. 260, pl. 287, fig. 1.
*Isobranchia ceylonensis* Yamaguti, 1963, p. 260, pl. 287, fig. 2.
*Clavellopsis appendiculata* Kirtisinghe, 1950, p. 84, figs. 40-43 ; Pillai, 1962d, p. 70, figs. 8-9 ; 1968d, p. 129, figs. 7-8.

*Female.*—Cephalothorax short but stout and bent backwards over the trunk, often curved into a semicircle. Carapace present. Trunk enlarged, widening backwards, with dorso-median longitudinal groove. Postero-median part with a small bilobed genital process. Trunk porcesses two pairs, first pair dorso-lateral, second ventro-median, one on either side of the genital lobe, ventral processes shorter than dorsal. Egg sacs cylindrical, longer than trunk processes.

Antennule four-jointed, second segment with inner seta, fourth with two spines and three setae. Antenna enclosed in a chitinous covering, exopod broad, with one spine, endopod clearly two-segmented, second segment with three spines. Mandible distally narrowed, with seven primary teeth, first three alternating with

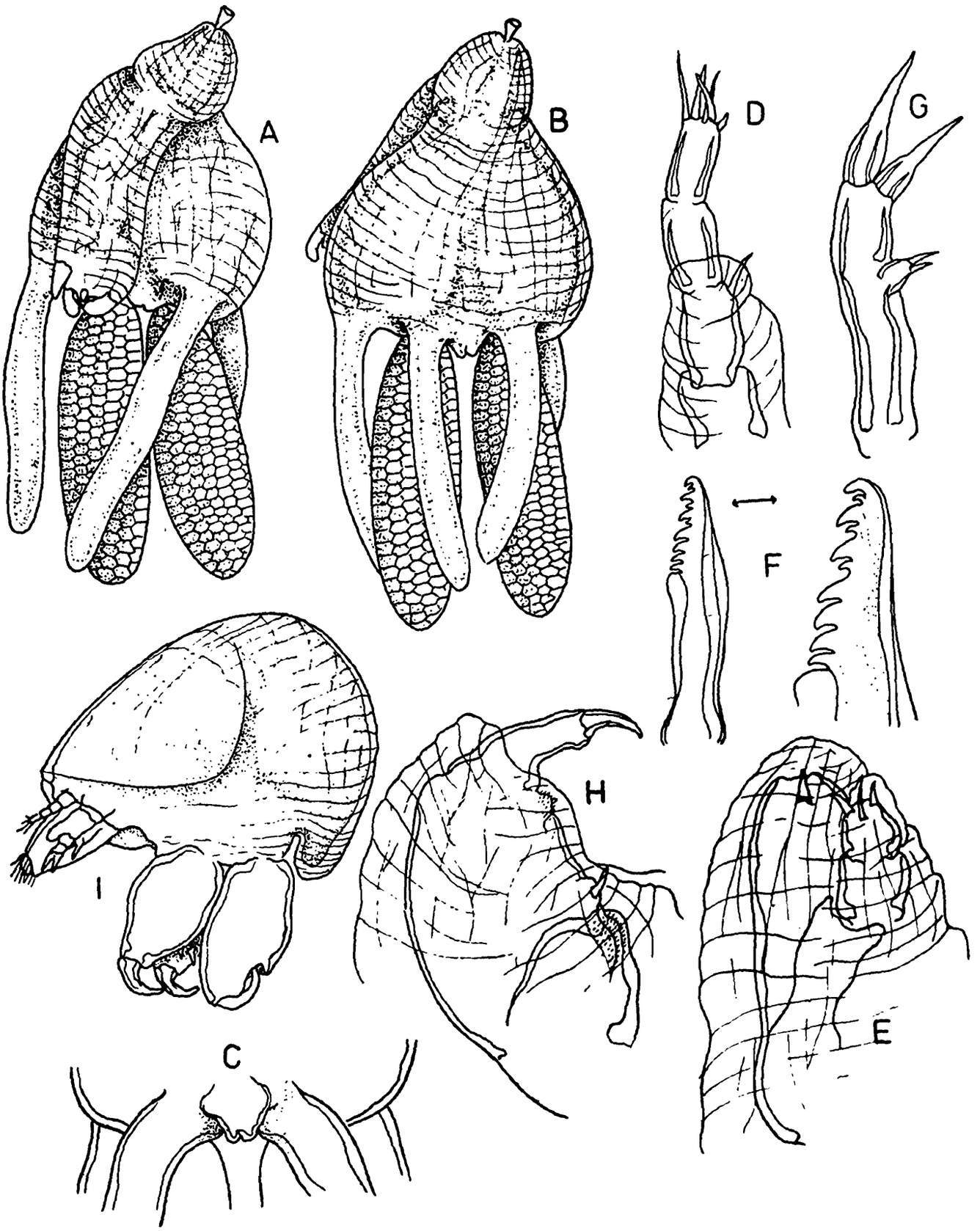


Fig. 277. *Isobranchia appendiculata* Heegaard : A, female, cephalothorax ventral, trunk dorsal ; B, same, trunk ventral, cephalothorax dorsal ; C, hind end of trunk, ventral ; D, antennule; E, antenna ; F, mandible ; G, maxillule ; H, maxilliped ; I, male.

secondary teeth. Maxillule rather slender, with two apical processes, palp with two spines. Maxillae short, completely fused into a conical process, bulla small, vine glass-shaped. Basal segment of maxilliped stout, with proximal and distal spiny pads and a median spine on the inner side, distal segment comparatively short, with a distal spine, unguis normally developed.

*Length.*—4.0 mm.

*Male.*—Body somewhat hemispherical, cephalothorax and trunk fully fused, carapace and caudal lobe well developed. Antennule four-jointed, distal segment with six setae. Sympod of antenna two-jointed, exopod with one spine, surface spinulose, endopod two-jointed, distal inner part of distal segment produced below the apical spine into a spiny lobe. Mandible with seven primary and three secondary teeth. Maxilla subchelate, basal segment with inner pustulose pad. Maxilliped with cup-like projection on basal segment, distal segment stout and strongly curved.

*Length.*—0.4 mm.

*Host.*—*Chirocentrus dorab.*

*Distribution.*—Persian Gulf, Sri Lanka, India (Kerala).

*Remarks.*—The reasons for considering *C. appendiculata* Kirtisinghe as a synonym of *I. appendiculata* were discussed in detail in my publication cited above. It may be pointed out that the descriptions of this species by Heegaard as well as Kirtisinghe are very unsatisfactory.

## Genus **Proclavellodes** Kabata

*Proclavellodes* Kabata, 1967b, p. 1298.

*Diagnosis.*—"Clavellinae. First antenna of normal lernaeopodid type. Second antenna bending in a characteristic ventral curve. Mandibular formula varied, with at least one secondary tooth. First maxilla as in *Clavellodes.* Second maxilla with aliform lateral expansion which, however, is rather less well developed than in *Clavellodes.*"

Parasites of teleosts.

Type species.—*P. pillaii* Kabata.

*Discussion.*—According to Kabata this genus shows close affinity to *Clavella* in the shape and position of the cephalothorax and in the absence of trunk processes. The presence of aliform expansions of the maxillae shows its relationship with *Clavellodes*. The same excludes it from *Clavella* and the mandibular formula and the structure of the antenna separate it from *Clavellodes*. The shape and armature of the antenna is the most characteristic feature of this genus.

## **Proclavellodes pillaii** Kabata
(Fig. 278)

*Proclavellodes pillaii* Kabata, 1967b, p. 1298, figs. 1-6.
*Clavella uncinata* Kirtisinghe, 1964, p. 120 (nec Muller 1776).

*Female.*—Cephalothorax long and slender, curved and bent over the trunk. Head without distinct carapace. Trunk slightly flattened dorso-ventrally, wider behind, lateral borders subparallel, hind part without processes but a small projection carrying the anus evident. Egg sacs long and cylindrical, eggs spherical.

Antennule short, indistinctly two-jointed, basal segment with outer distal seta, second with four setae and a sharp spine. Antenna with stout conspicuously incurved sympod, exopod bulbous, externally spinulose and with a long seta near its base, endopod two-jointed, as long as exopod but narrower, internally spiny and apically armed with three spines and a rounded lobe. Mandible flat, dentition slightly variable, typically with six primary teeth, first two alternating with subsidiary teeth. Maxillule with two large apical spines, palp represented by one large seta. Maxillae reduced, completely fused, expanding into aliform swellings forming a collar around the maxillae. Bulla long and club-shaped. Basal segment of maxilliped with inner median spine, distal segment with small proximal spine and a long unguis below which the ventral border carries a patch of denticles, a short spine and a long spine.

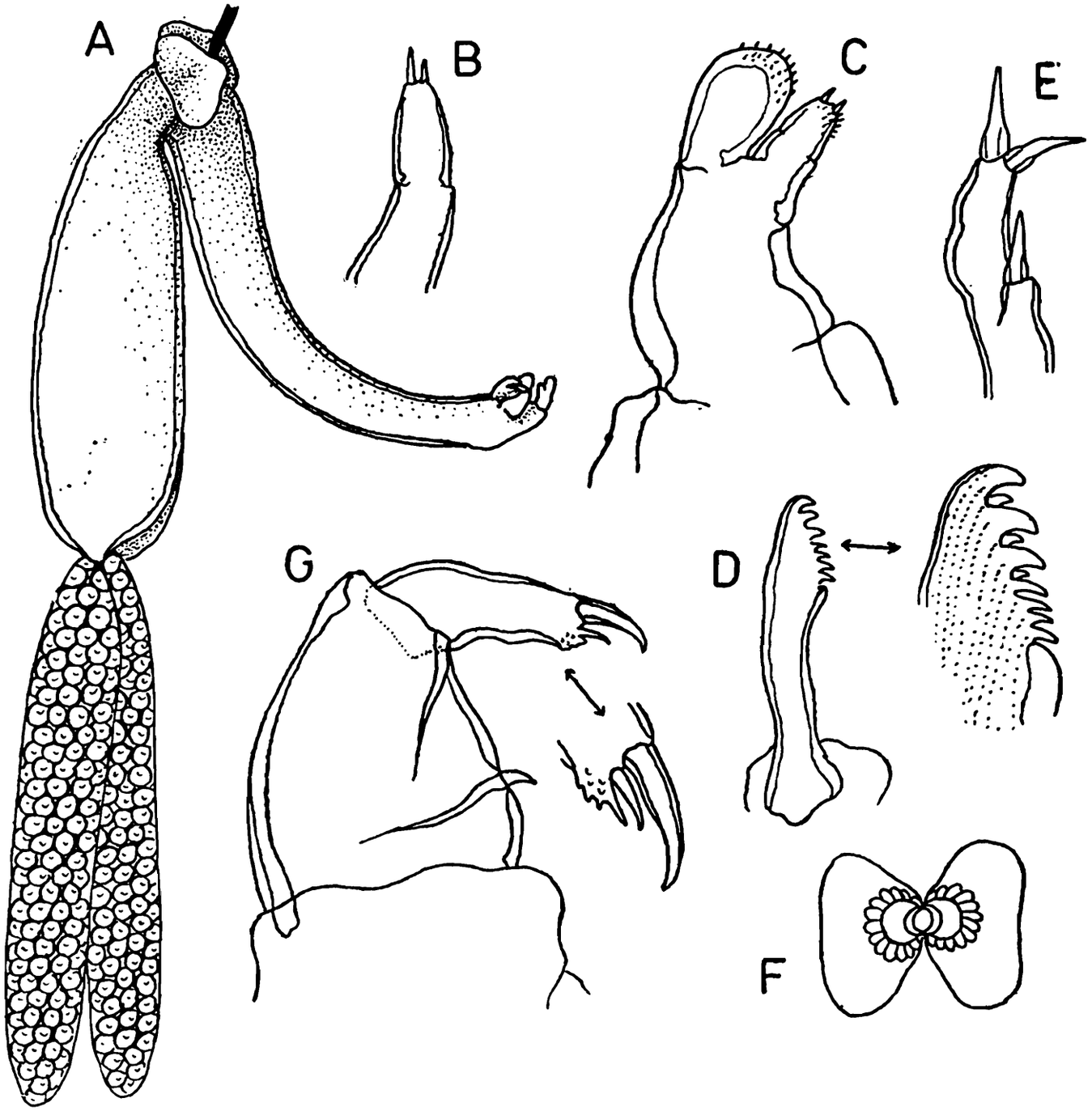


Fig. 278. *Proclavellodes pillaii* Kabata : A, female, lateral view ; B, antennule ; C, antenna ; D, mandible ; E, maxillule ; F, tip of maxillae ; G, maxilliped.

*Length.*—3.2 mm.

*Host.*—*Gazza minuta.*

*Distribution.*—India (Kerala).

*Remarks.*—The above description is mainly based on the publication by Kabata. The description shows slight difference com-

pared to the figures included here. As the head of the animal is extremely small I could not study all the appendages accurately.

From *Gazza minuta* Kirtisinghe collected specimens which he identified as *Clavella uncinata*. When compared with the most recent description of this species by Shiino (1956b) *C. uncinata* is quite different from *P. pillaii*. However, I suggest the possiblility that Kirtisinghe's specimens belong to *P. pillaii*.

## Genus **Clavellopsis** Wilson

*Clavellopsis* Wilson, 1915, p. 686 ; Yamaguti, 1963, p. 255.

*Diagnosis*.—Cephalothorax comparatively short but stout, inclined backwards. Carapace present. Trunk generally broader than long, with prominent postero-median genital process, abdomen and caudal rami absent. Trunk processes generally absent, when present very small. Antennule four-jointed. Antenna biramous, endopod two-jointed. Mandible with a small number of teeth. Maxillule apically with two spines. Maxilla moderately long, completely fused and apically expanding into lobes.

Male typically clavelline.

Parasites of teleosts.

Type species.—*C. laciniata* (Kroyer)

*Discussion*.—As already pointed out this genus includes species with or without trunk processes though it has been pointed out that the processes if present are small. The genus apparently needs a precise definition.

### **Clavellopsis bilobata** Pillai
(Fig. 279)

*Clavellopsis bilobata* Pillai, 1962d, p. 72, fig. 10.

*Female*.—Cephalothorax comparatively short, its length equal to the width of the trunk, slightly inclined backwards. Head not

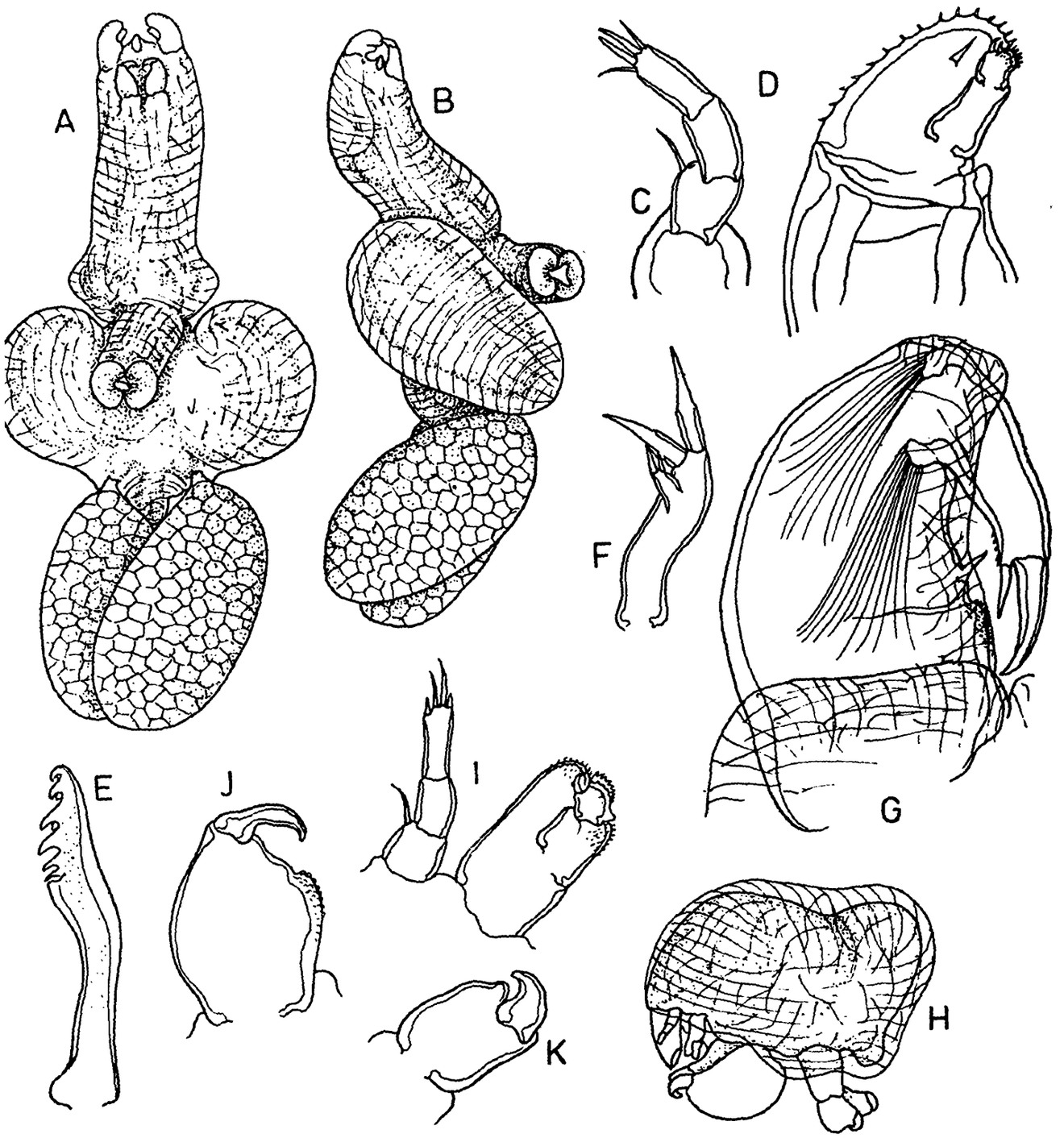


Fig. 279. *Clavellopsis biloba* Pillai : A, female, ventral view ; B, same, lateral view ; C, antennule ; D, antenna ; E, mandible ; F, maxillule ; G, maxilliped ; H, male ; I, antennule and antenna ; J, maxilla ; K, maxilliped.

enlarged. Carapace present. Hind part of cephalothorax swollen to accommodate the maxillary glands, constricted beyond to meet the trunk. Trunk twice as broad as long, demarcated into two nearly circular lobes by a median longitudinal groove. Trunk without processes, postero-medially prolonged into a large genital lobe. Egg sacs large, attached to prominent trunk lobes situated on either side of the genital process.

Antennule clearly four-jointed, second segment with one seta, fourth with two setae and two spines. Antenna narrowing distalwards, exopod with spiny surface, spines on the borders projecting, endopod two-jointed, distal segment distally strongly spiny and with a claw. Mandible with double curve, with six primary teeth, first three alternating with subsidiary teeth, fourth tooth largest. Maxillule rather slender, ending in two fairly large processes, palp with two spines. Maxillae fused into a cylindrical lobe, apically forming two semicircular lobes flanking the small bulla. Maxilliped robust, basal segment with a proximal spinulose bulge followed by a spine, distal segment very long, with a lower distal spine at the base of the unguis, latter stout and moderately curved.

*Length.*—2.5 mm.

*Male.*—Male typically clavelline. Cephalothorax fully fused with trunk, carapace and caudal lobe distinct. Antennule three-jointed, first segment with a seta, fourth with two short spines and two setae. Exopod of antenna apically spiny, basal segment of endopod with an inner distal patch of spines, distal segment with a claw and a serrated crest. Maxillae two-jointed, basal segment with a tuberculated inner bulge, distal segment slender. Maxilliped smaller than maxillae, distal segment short but stout.

*Length.*—0.7 mm.

*Host.*—*Nemipterus japonicus.*

*Distribution.*—India (Kerala).

*Type.*—In the National Zoological Collection at Zoological Survey of India, Calcutta. Reg. No. C2170/2.

## Family SPHYRIIDAE

*Diagnosis.*—Body demarcated into head, neck and trunk, segmentation absent. Head and neck with or without knobs or processes. Trunk dorso-ventrally flattened, with a pair of posterior trunk processes, branched or unbranched. Abdomen small, with or without caudal rami. Egg sacs long and cylindrical. Cephalic appendages much reduced but what appears to be mandibles, maxillules, maxillae and maxillipeds present. Attachment effected by burrying the head in the body of the host.

Male a pigmy attached to the female. Body curved or straight, demarcated into cephalothorax and trunk. Antennules, antennae, mandibles, maxillules, maxillae and maxillipeds present, almost exactly as in lernaeopodids.

*Discussion.*—Yamaguti (1963) placed seven genera in this family, namely, *Periplexis* Wilson (1944), *Paeonodes* Wilson (1944), *Opimia* Wilson (1919), *Paeon* Wilson (1919), *Tripaphylus* Richiardi (1880), *Lophoura* Kolliker (1853) and *Sphyrion* Cuvier (1830). *Paeonodes* belongs to Cyclopoida. Only *Paeon* and *Trypaphylus* have been recorded from Indian waters.

Though many sphyriids have been described recently only Lewis (1966b) has attempted to study the appendages of the female. He has described them with some reservation but gave an excellent account of those of the male.

### *Key to genera of* SPHYRIIDAE

| | | |
|---|---|---|
| 1. | Head with globular lobes | **Paeon** Wilson |
| — | Head with a pair of lateral horns | .**Tripaphylus** Richiardi |

## Genus **Paeon** Wilson

*Paeon* Wilson, 1919, p. 591 ; 1932, p. 524 ; Yamaguti, 1963, p. 310.

*Diagnosis.*—Head transversely expanded, its ventral surface raised into paired globular lobes. Neck long and slender, without processes. Trunk broadening backwards, with a pair of unbranched cylindrical posterior trunk processes. Abdomen small, with a pair

of small caudal rami. Egg tubes long and straight. Appendages as in family.

Male with cephalothorax covered by a carapace. Trunk with a partition, second segment with a pair of posterior processes followed by the caudal rami. Appendages as in lernaeopodid males.

Parasites of elasmobranchs.

Type species.—*P. ferox* Wilson.

*Discussion.*—This genus contains five species besides an unnamed one. They are *P. ferox* Wilson (1919), *P. elongatus* Wilson (1932), *P. vaissieri* Delamare-Deboutteville and Nunes-Ruivo (1954b), *P. versicolor* Wilson (1919), and *P. lobatus* Kirtisinghe (1964). The last species alone has been recorded from Indian waters.

### **Paeon lobatus** Kirtisinghe

*Paeon lobatus* Kiritisinghe, 1964, p. 123, figs. 180-183.

*Female.*—Head transversely expanded, antero-laterally produced into a pair of large globular lobes and postero-laterally into a pair of similar but smaller lobes. Ventrally the mouth is flanked by a pair of triangular lobes. Posteriorly there is an oval median lobe flanked by two pairs of lobes forming two oblique rows and between the above there is a pair of small lobes. Neck smooth and cylindrical, about as long as trunk. Trunk club-shaped, faintly demarcated into three segments. Hind part of trunk with a pair of postero-lateral genital lobes and a pair of cylindrical posterior processes. Abdomen bilobed.

*Length.*—29.3 mm.

*Host.—Hemipristis elongatus*

*Distribution.*—Sri Lanka.

*Type.*—In the Colombo Museum.

*Remarks.*—The above description is from Kirtisinghe. According to him this species differs from the others in the presence of a pair of genital lobes. But it may be remarked that in *P. vaissieri* the trunk is posteriorly lobed and the head is identical in these two species. A comparative study of these two species will therefore be desirable.

## Genus **Tripaphylus** Richiardi

*Tripaphylus* ; Yamaguti, 1963, p. 312.
*Tripaphylus* ; Kirtisinghe, 1964, p. 124.

*Diagnosis.*—Head transversely expanded, with a pair of apically acute lateral processes. Neck slender, widening backwards. Trunk as long as neck or shorter, widening backwards, with a pair of posterior unbranched processes. Abdominal process bilobed. Antennule four-jointed, with apical spines. Antenna biramous, endopod chelate. Maxillule as in lernaeopodids. Maxillipeds very large.

Cephalothorax of male with carapace, trunk segmented, ending in a pair of caudal rami. Maxillipeds long and jointed, other appendages as in lernaeopodids.

Parasites of elasmobranchs.

Type species.—*T musteli* (van Beneden).

*Discussion.*—This genus includes two species, *T musteli* (van Beneden) and *T hemigalei* Kirtisinghe (1964). The characters of the genus, particularly those of the appendages are not clearly known.

### **Tripaphylus hemigalei** Kirtisinghe

*Tripaphylus hemigalei* Kirtisinghe, 1964, p. 124, figs. 184-191.

*Female.*—Head comparatively large, broader than long and anteriorly trilobed, with a pair of lateral chitinised horns directed outwards and backwards, narrowing towards the tip. Neck anteriorly very narrow, gradually widening backwards and demar-

cated from trunk by a slight constriction. Trunk nearly as long as neck, demarcated into two equal parts by a constriction, postero-medially produced into a small, bilobed abdominal process giving rise from near its base to a pair of unbranched cylindrical trunk processes. Egg sacs twice as long as trunk processes.

Antennule four-jointed, with two apical spines. Antenna biramous, exopod with two apical spines, margin between the spines serrated, endopod chelate ? Maxillule with three apical spines. Maxillipeds large.

*Length.*—14.3 mm.

*Male.*—Cephalothorax widening backwards, with carapace, trunk cylindrical and three-jointed, shorter than cephalothorax, abdomen indistinct, with small pointed caudal rami, each with a spine. Antennule four-jointed, apical segment with one long and two short spines. Antenna biramous, exopod apically rounded, with two spines, endopod two-jointed, terminal joint with three spines, the outer long and curved. Maxillae short, three-jointed. Maxillipeds long, three or four-jointed, reaching beyond the caudal rami.

*Length.*—1.2 mm.

*Host.—Hemigaleus balfouri.*

*Distribution.*—Sri Lanka.

*Types.*—In the Colombo Museum.

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## LIST OF SYNONYMS

| Junior Synonym | Senior Synonym |
|---|---|
| *Alebion alatus* Gnanamuthu | *Alebion maculatus* |
| *Alebion megacephalus* Kirtisinghe | *Alebion maculatus* |
| *Alebion spinosus* Rangnekar | *Alebion maculatus* |
| *Anuretes branchialis* Rangnekar | *Heniochophilus branchialis* |
| *Bomolochus aculeatus* Pillai | *Orbitacolax aculeatus* |
| *Bomolochus denticulatus* Bassett-Smith | *Nothobomolocus denticulatus* |
| *Bomolochus jonesi* Bennet | *Pumiliopes jonesi* |
| *Bomolochus kanagurta* Pillai | *Nothobomolochus kanagurta* |
| *Bomolochus multispinosus* Gnanamuthu | *Nothobomolochus multispinosus* |
| *Bomolochus sardinellae* Bennet | *Pumiliopsis sardinellae* |
| *Bomolochus tetradonis* Bassett-Smith | *Taeniacanthus tetradonis* |
| *Bomolochus triceros* Bassett-Smith | *Nothobomolochus triceros* |
| *Bomolochus varunae* Bennet | *Pseudorbitacolax varunae* |
| *Brachiella gulosa*, Kirtisinghe | *Brachiella trichiuri* |
| *Brachiella indica* Tripathi | *Brachiella albida* |
| *Brachiella indica* Pillai | *Brachiella lutiani* |
| *Caetrodes pholas* Wilson | *Hatschekia pholas* |
| *Caligodes carangis* Bassett-Smith | *Parechetus carangis* |
| *Caligotrogus kapuri* Ummerkutty | *Dissonus kapuri* |
| *Caligus acutus* Kirtisinghe | *Caligus savala* |
| *Caligus affinis* Kurian | *Caligus savala* |
| *Caligus alalongae*, Kirtisinghe | *Caligus confusus* |
| *Caligus benedeni* Bassett-Smith | *Sciaenophilus benedeni* |
| *Caligus bombayensis* Rangnekar | *Caligus platytarsis* |
| *Caligus brevisoris*, Pillai | *Caligus cybii* |
| *Caligus cossacki* Rangnekar and Murti | *Caligus epinepheli* |
| *Caligus cunicephalus* Gnanamuthu | *Caligus savala* |
| *Caligus djedabae* Rangnekar | *Caligus bicycletus* |
| *Caligus dussumieri* Rangnekar | *Pseudopetalus dussumieri* |
| *Caligus hilsae* Shen | *Caligus unguidentatus* |
| *Caligus hirsutus* Bassett-Smith | *Parapetalus hirsutus* |
| *Caligus krishnai* Thomas | *Caligus bonito* |
| *Caligus lepeophtheropsis* Pillai | *Caligus furcisetifer* |
| *Caligus longicervicis* Gnanamuthu | *Caligus uruguayensis* |
| *Caligus minutus* Pillai | *Caligus chiloscyllii* |
| *Caligus parvus* Bassett-Smith | *Pseudocaligus parvus* |
| *Caligus pteroisi* Kurian | *Caligus russellii* |
| *Caligus scabiei* Gnanamuthu | *Caligus longipedis* |
| *Caligus sphyraeni* Pillai | *Caligus clavatus* |
| *Caligus thynni* Pillai | *Caligus asymmetricus* |
| *Cardiodectes medusaeus* Kirtisinghe | *Cardiodectes anchorellae* |
| *Charopinus albida* Rangnekar | *Brachiella albida* |
| *Charopinus dasyaticus* Pillai | *Pseudocharopinus kabatai* |
| *Charopinus narcinae* Pillai | *Pseudocharopinus narchinae* |
| *Chondracanthus alatus* Heller | *Protochondracanthus alatus* |

| Junior Synonym | Senior Synonym |
|---|---|
| *Chondracanthus trilobatus* Pillai | *Protochondracanthus trilobatus* |
| *Clavellisa chordata* Pillai | *Clavellisa pellonae* |
| *Clavellisa emarginata* Pillai | *Clavellisa obchordata* |
| *Clavellisa ilishae* Pillai | *Clavellisa hilsae* |
| *Clavellopsis appendiculata* Kirtisinghe | *Isobranchia appendiculata* |
| *Clavellopsis dasyaticus* Rangnekar | *Pseudocharopinus dasyaticus* |
| *Dentigryps longicauda* Cressey | *Lepeophtheirus cressey* |
| *Euryphorus nympha*, Kirtisinghe | *Euryphorus nordmanni* |
| *Gloiopotes longicaudatus*, Kirtisinghe | *Gloiopotes watsoni* |
| *Gloiopotes zeugopteri* Rao | *Gloiopotes huttoni* |
| *Indocaligus echinus* Pillai | *Lepeophtheirus longipalpus* |
| *Kroyeria elongata* Pillai | *Kroyeria spatulata* |
| *Lernanthropus carangis* Pillai | *Lernanthropus indicus* |
| *Lernanthropus cornutus* Kirtisinghe | *Lernanthropus tylosuri* |
| *Lernanthropus kanagurta* Tripathi | *Lernanthropus corniger* |
| *Lernanthropus latesi* Tripathi | *Lernanthropus latis* |
| *Lernanthropus pomadasysis* Rangnekar and Murti | *Lernanthropus abitocephalus* |
| *Lernanthropus priacanthi* Kirtisinghe | *Aethon priacanthi* |
| *Midias carangis* Rangnekar | *Caligus constrictus* |
| *Midias lobodes* Wilson | *Caligus lobodes* |
| *Norion globosus* Pillai | *Aethon globosus* |
| *Pandarus longus* Gnanamuthu | *Pseudopandarus longus* |
| *Parapetalus caudatus* Gnanamuthu | *Pseudopetalus caudatus* |
| *Parapetalus formicoides* Rangnekar and Murti | *Pseudopetalus formicoides* |
| *Parapetalus gunteri* Pearse | *Parapetalus occidentalis* |
| *Pennella cervicornis* Heegaard | *Pennella diodontis* |
| *Pennella zeylanica* Kirtisinghe | *Pennella instructa* |
| *Perissopus manuelensis* Gnanamuthu | *Perissopus dentatus* |
| *Perissopus travancorensis* Kurian | *Perissopus dentatus* |
| *Platyporinus alatus* Rao | *Alenbion crassus* |
| *Protochondracanthus psettodes* Kirtisinghe | *Protochondracanthus alatus* |
| *Pseudochondracanthus longitruncus* Pillai | *Heterochondria pillaii* |
| *Pseudochondracanthus* sp. Pillai | *Ceratochondria hoi* |
| *Pseudopandarus bombayensis* Rangnekar and Rangnekar | *Pseudopandarus longus* |
| *Pseudopandarus shiinoi* Rangnekar and Rangnekar | *Pseudopandarus longus* |
| *Pumiliopsis spathepedes* Bennet | *Pumiliopsis plautus* |
| *Sciaenophilus inopinus* Humes | *Sciaenophilus pharaonis* |
| *Thysanote decemfimbriata* Pillai | *Thysanote eleutheronemi* |
| *Thysanote octofimbriata* Tripathi | *Thysanote eleutheronemi* |
| *Thysanotella multifimbriata* Bassett-Smith | *Thysanote multifimbriata* |
| *Tuxophorus cybii* Nunes-Ruivo and Fourmanoir | *Tuxophoropsis cybii* |
| *Tuxophorus solandri* Kurian | *Tuxophoropsis cybii* |
| *Tuxophorus tylosuri* Rangnekar | *Caligus tylosuri* |

## LIST OF HOSTS AND THEIR PARASITES

*Ablennes hians* (Val.)
- Bomolochus bellones
- Caligodes laciniatus
- Caligus malabaricus
- Lernanthropus tylosuri
- Nothobomolochus gibber
- Pseudopetalus caudatus

*Acanthocybium solandri* (Cuv.)
- Brachiella thynni
- Caligus coryphaenae
- Gloiopotes hygomianus
- Lernaeenicus seeri
- Lernaeolophus sultanus
- Tuxophoropsis cybii

*Acanthopagurus berda* (Forsk.) = *Chrysophrys berda* (Forsk.)
- Caligus cossacki

*Acanthopagurus olivaceus* Bl. & Schn.
- Caligus laticaudus

*Aetomylaeus nichofii* (Bl. & Schn.)
- Pseudocharopinus dasyaticus
- Pseudocharopinus kabatai

*Alectis indicus* (Ruppell)
- Caligus constrictus
- Parapetalus orientalis

*Alutera shoepfi* (Walbaum)
- Lernaeolophus sultanus

*Aluteres scriptus* Blk.
- Caligus polycanthi

*Alopias pelagicus* Nakamura
- Echthrogaleus denticulatus

*Alopias superciliosus* Lowe = *Alopias vulpinus* (Bonnaterre)
- Bariaka alopiae
- Dinemoura descrepans
- Pagina tunica

*Alopias vulpinus* (Bonnaterre)
Dinemoura descrepans
Dinemoura latifolia
Echthrogaleus denticulatus
Nemesis aggregatus
Nemesis lamna
Pandarus smithii
*Amphotistius kuhlii* (Mull. & Henle)=*Dasyatis kuhlii* (Mull. & Henle)
Caligus dasyaticus
*Anchoviella bataviensis* Hardenberg
Lernaeenicus anchoviellae
*Anodontostoma chacunda* (Ham.-Buch.)
Pseudorbitacolax varunae
*Aprionodon isodon* (Mull. & Henle)
Eudactylina aspera
Kroyeria gracilis
*Ariodes dussumieri* (Val.)=*Tachysurus dussumieri* (Val.)
Hermilius longicornis
Lepeophtheirus longipalpus
*Arius acutirostris* Val.=*Tachysurus acutirostris* (Val.)
Caligus arii
Hermilius longicornis
Hermilius pyriventris
Lepeophtheirus longipalpus
*Arius dussumieri* Cuv. & Val.=*Tachysurus dussumieri* (Val.)
Caligus arii
Caligus dakari
Hermilius longicornis
*Arius hendeloti* Boulanger=*Tachysurus hendeloti* (Val.)
Hermilius pyriventris
*Arius nenga* Blk.=*Tachysurus nenga* (Blk.)
Caligus nengai
*Atule djedaba* (Forsk.)
Caligus bicycletus
Caligus robustus
*Autisthes puta* (Cuv.)=*Therapon puta* Cuv.
Caligus diaphanus
*Auxis thazard* (Lacepede)
Caligus auxisi
Caligus productus

*Balistes fuscus* Bl. & Schn.
Caligus polycanthi
*Balistes maculatus* Blk.=*Canthidermis maculatus* (Bloch)
Caligus polycanthi
*Bathystoma remator* ?
Caligus robustus
*Belone belone* (Linn.)
Bomolochus bellones
Nothobomolochus gibber
*Belone svetovidovi* Collette & Parin
Bomolochus bellones
Nothobomolochus gibber
*Bembrops caudimaculata* Steindachner
Taeniacanthus dentatus
*Calamus brachysomus* = *Calamus brachyurus* (Lockington)
Caligus productus
*Callyodon ovifrons* (Temm. & Schl.)
Lepeophtheirus goniistii
Lepeophtheirus spinifer
*Canthidermis maculatus* (Bloch)
Caligus polycanthi
*Carangoides armatus* (Forsk.)
Thysanote heterodactyla
*Carangoides jerdon* (Forsk.) = *Carangoides ferdau* (Forsk.)
Lernanthropus giganteus
*Carangoides malabaricus* (Bloch)
Bomolochus monoceros
Caligus constrictus
Thysanote longimana
*Caranx carangus* (Bloch)
Lernanthropus giganteus
*Caranx crysos* (Mitchill)
Caligus longipedis
Caligus robustus
Caligus tenax
Lernaeenicus longiventris
Lernanthropus giganteus
*Caranx djedaba* (Forsk.)
Bomolochus megaceros

*Caranx hippos* (Linn.)
Caligus confusus
Caligus coryphaenae
Caligus robustus
Caligus tenax
Lepeophtheirus cresseyi
Lernaeenicus longiventris
Lernanthropus giganteus
*Caranx ignobilis* (Forsk.)
Lernaeenicus longiventris
Parapetalus longipennatus
*Caranx jerdon* (Forsk.) = *Carangoides ferdau* (Forsk.)
Parechetus carangis
*Caranx lugubris* Poey
Caligus longipedis
*Caranx melampygus* Cuv.
Caligus confusus
Caligus coryphaenae
Caligus longipedis
Caligus platurus
Caligus robustus
Lernanthropus giganteus
Parechetus constrictus
*Caranx nigrescens* (Ogilby)
Parapetalus longipennatus
*Caranx sansun* (Forsk.)
Caligus confusus
Caligus robustus
Lernanthropus indicus
*Caranx senegalensis* Cuv. = *Caranx senegallus* Cuv.
Lernanthropus giganteus
*Caranx speciosus* Ogilby
Caligus rotundigenitalis
*Caranx stellatus* Eydoux & Souleyet
Parapetalus longipennatus
*Carcharias commersoni* (Blainville)
Kroyeria gracilis
Paralebion elongatus
*Carcharias limbatus* (Mull.& Henle)=*Carcharhinus limbatus* Mull. &
Alebion maculatus Henle

Eudactylina aspera
Kroyeria gracilis
Kroyeria longicauda
Kroyeria spatulata
Pandarus smithii
Paralebion elongatus

*Carcharias littoralis* ?
Anthosoma crassum
Kroyeria spatulata

*Carcharias maculipinnis* (Poey)=*Carcharhinus maculipinnis* (Poey)
Eudactylina aspera
Kroyeria spatulata
Nemesis versicolor

*Carcharias obscurus* Gunther=*Eulamia obscurus* (Le Sueur)
Pandarus smithii
Paralebion elongatus

*Carcharias pleurotaenia* (Blk.)
Eudactylina aspera

*Carcharias taurus* Rafinesque
Alebion gracilis
Pandarus smithii

*Carcharhinus acronotus* (Poey)
Kroyeria sphyrnae

*Carcharhinus azureus* ?
Pandarus smithii

*Carcharhinus brachyurus* (Gunther)
Pandarus cranchii

*Carcharhinus galapagensis* Snodgrass & Henle
Pandarus smithii

*Carcharhinus gangeticus* (Mull. & Henle)
Pandarus carcharini

*Carcharhinus lamiella* (Jordan & Gilbert)
Alebion gracilis

*Carcharhinus leucas*(Rochebrune)=*Eulamia commersonii* (Blainville)
Kroyeria gracilis
Kroyeria spatulata
Pandarus carcharini
Paralebion elongatus

*Carcharhinus limbatus* Mull. & Henle=*Eulamia limbatus* (Mull. &
Alebion maculatus Henle)

Eudactylina aspera
Kroyeria gracilis
Kroyeria longicauda
Kroyeria spatulata
Pandarus carcharini
Pandarus smithii
Paralebion elongatus

*Carcharhinus longimanus* (Poey)
Kroyeria gracilis

*Carcharhinus malpeloensis* (Fowler)
Pandarus cranchii
Pandarus smithii

*Carcharhinus milberti* Roule=*Eulamia plumbeus* (Nardo)
Echthrogaleus coleoptratus
Kroyeria gracilis
Pandarus smithii
Paralebion elongatus

*Carcharhinus obscurus* (Le Sueur)=*Eulamia obscurus* (Le Sueur)
Alebion gracilis
Anthosoma crassum
Kroyeria gracilis
Pandarus cranchii
Pandarus smithii

*Carcharhinus platyrhyncus* (Gilbert)
Alebion gracilis

*Carcharhinus sorrah* (Mull. & Henle)
Kroyeria spatulata
Pandarus carcharini

*Carcharodon carcharias* (Linn.)
Anthosoma crassum
Dinemoura latifolia
Echthrogaleus coleoptratus
Echthrogaleus denticulatus
Nemesis lamna
Pandarus smithii

*Carcharodon rondelettii* (Mull. & Henle)=*Carcharodon carcharias* (Linn.)
Dinemoura latifolia

*Centrophorus granulosus* (Schn.)
Echthrogaleus coleoptratus

*Cetorhinus maximus*=*Halsydrus maximus* (Gunner)
Anthosoma crassum
Nemesis lamna
*Chatoessus nasus* cuv. & Val.=*Nematalosa nasus* (Bloch.)
Clavellisa obchordata
Lernanthropus rubiginosus
*Chanos chanos* (Forsk.)
Lernanthropus cadenati
*Chiloscyllium indicum* (Gmelin)
Caligus chiloscyllii
Taeniacanthus indicus
*Chiloscyllium punctatum* Mull. & Henle
Eudactylina aspera
*Chirocentrus dorab* (Forsk.)
Brachiella thynni
Caligus longicaudus
Isobranchia appendiculata
Lernanthropus chirocentrosus
*Chorinemus lysan* (Forsk.)
Caligus epinepheli
Caligus tylosuri
Lepeophtheirus spinifer
Lernanthropodes chorinemi
Tuxophorus wilsoni
*Chorinemus sanctipetri* Cuv.
Lernanthropodes chorinemi
*Chorinemus tala* Cuv.
Caligus epinepheli
Lepeophtheirus spinifer
*Chrysophrys aurata* Murray & Hjort=*Sparus aurata* Linn.
Caligus productus
Sciaenophilus pharaonis
*Chrysophrys berda* (Forsk.)
Lernanthropus chrysophrys
*Chrysophrys bifasciatus* (Blk)=*Acanthopagurus bifasciatus* (Forsk.)
Sciaenophilus pharaonis
*Chrysophrys sarba* (Forsk.)
Caligus chrysophrysi
*Coilia dussumieri* Cuv. & Val.
Clavellisa phasa

Peroderma cylindricum

*Coryphaena equisetis* Linn.

Euryphorus nordmanni

*Coryphaena hippurus* Linn.

Caligus confusus
Caligus coryphaenae
Caligus productus
Caligus quadratus
Charopinopsis quaternia
Euryphorus nordmanni
Lernaeenicus longiventris

*Coryphaena pelagica* Gunther=*Coryphaena hippurus* Linn.

Caligus coryphaenae

*Cratinus agassizi ?*

Caligus bonito

*Cybium commersoni* (Lacepede)=*Scomberomorus commersoni* (Lacepede)

Caligus cybii
Caligus infestans
Tuxophoropsis cybii

*Cybium guttatum* Day=*Scomberomorus guttatus* (Bl. & Schn.)

Caligus phipsoni

*Cybium maculatum* Vinciguerra=*Scomberomorus maculatus* (Mitchill)

Caligus infestans

*Cybium sphyraenae*=*Scomberomorus sphyraenae* ?

Caligus infestans

*Cypselurus agoo* (Temm. & Schl.)

Nothobomolochus cypseluri

*Cypselurus behiensis* Day

Pennella longicauda

*Cypselurus spilopterus* Jord. & Richardson=*Cypselurus bahiensis* Day

Pennella platycephala

*Dasyatis akajei* (Mull. & Henle)

Caligus dasyaticus

*Dasyatis fluviorum* Ogilby

Pseudocharopinus kabatai

*Dasyatis imbricatus* (Bl. & Schn.)

Pseudocharopinus kabatai

*Dasyatis uarnak* (Forsk.)

Caligus dasyaticus
Pseudocharopinus dasyaticus

Pseudocharopinus kabatai

*Decapterus russelli* (Ruppell)

Lernanthropus decapteri

*Diodon hystrix* Linn.

Hatschekia elliptica
Peniculisa furcata
Peniculisa wilsoni

*Diodon maculatus* Smith=*Diodon maculifer* Smith

Pennella diodontis

*Diodon maculifer* Smith

Pennella diodontis

*Diodon sexmaculatus* Cuv.

Pennella diodontis

*Diplodus annularis* (Linn.)

Lernaeolophus sultanus

*Drepane punctata* (Linn.)

Caligus epinepheli

*Dussumieria acuta* Val.

Clavellisa dussumieriae
Lernanthropus dussumieri
Nothobomolochus multispinosus
Pseudopetalus caudatus
Pseudopetalus dussumieri
Pseudopetalus formicoides

*Dussumieria hasseltii* Blk.

Clavellisa dussumieriae
Nothobomolochus multispinosus
Pseudopetalus caudatus
Pseudopetalus dussumieri
Pseudopetalus formicoides

*Echeneis albescens* Temm. & Schleg.

Lepeophtheirus crassus

*Echeneis naucrates* Linn.

Tuxophorus caligodes

*Elegatis bipinnulatus* (Quoy & Gaimard)

Caligus coryphaenae

*Eleutheronema tetradactylum* (Shaw)

Heniochophilus branchialis
Parapetalus hirsutus
Thysanote eleutheronemi

*Elops saurus* Richardson
Caligus productus
*Elops senegalensis* Regan=*lops saurus* Linn.
Lernanthropus cadenati
*Enneacentrus sonnerati* (Val.)
Sagum enneacentri
*Epinephelus akaara* Blk.
Caligus epinepheli
Lernaeenicus ramosus
Sagum epinepheli
*Epinephelus alexandrinus* Boulenger=*Serranus alexandrinus* Val.
Lepeophtheirus rotundiventris
*Epinephelus gigas* Broussonet=*Epinephelus guaza* (Linn.)
Lepeophtheirus rotundiventris
*Epinephelus merra* Bloch
Caligus epinepheli
Sagum epinepheli
*Epinephelus morrhua* (Val.)
Lernaeenicus ramosus
*Epinephelus septemfasciatus* (Thunberg)
Caligus epinepheli
*Epinephelus tsirimenaria* Blk.
Lernaeenicus ramosus
*Ethmalosa dorsalis* Regan=*Ethmalosa fimbriata* (Bowdich)
Peroderma cylindricum
*Hemipristis elongatus* (Kluzinger)
Paeon lobatus
*Hemirhamphus far* Ruppell
Bomolochus denticulatus
Lernaeenicus hemirhamphi
Nothobomolochus denticulatus
*Hemirhamphus intermedius* Cantor
Lernaeenicus hemirhamphi
*Hemirhamphus sajori* Temm. & Schl.
Lernaeenicus sayori
*Hemirhamphus xanthopterus* Cuv. & Val.
Lernaeenicus hemirhamphi
*Hilsa ilisha* (Hamilton)
Clavellisa hilsae

*Hilsa reeversi* (Richardson)
Caligus unguidentatus
*Hilsa toli* Day=*Hilsa sinensis* Linn.
Caligus unguidentatus
*Histiophorus brevirostris* Playfair=*Makaira indica* (Cuv.)
Gloiopotes huttoni
Gloiopotes watsoni
Pennella biloba
*Histiophorus gladius* (Broussonnet)
Gloiopotes huttoni
Gloiopotes watsoni
Pennella instructa
*Histiophorus herschelli*=*Makaira nigricans* Lacepede
Gloiopotes huttoni
*Histiophorus orientalis* Schlegel
Caligus quadratus
*Holocentrus rubrum* (Forsk.)
Caligus holocentri
*Hypoprion signatus*
Pandarus smithii
*Ilisha filigera* (Val.)
Caligus hilsae
Clavellisa hilsae
*Ilisha indica* Blk.=*Ilisha melastoma* (Schn.)
Clavellisa pellonae
*Indocybium guttatum* (Bl. & Schn.)=*Scomberomorus guttatus* (Bl. & Schn.)
Caligus cybii
Pseudocycnus armatus
*Indocybium lineolatum* (Cuv.)=*Scomberomorus lineolatus* Cuv & Val.
Brachiella thynni
Caligus cybii
*Istiompax australis*=*Makaira indica* (Cuv.)
Gloiopotes huttoni
Pennella instructa
*Istiophorus gladius* (Broussonnet)=*Histiophorus gladius* (Broussonnet)
Lernaeolophus sultanus
*Istiophorus orientalis* (Schlegel)=*Histiophorus orientalis* Schlegel
Gloiopotes huttoni
Gloiopotes watsoni

*Isuropsis glauca* (Mull. & Henle)=*Isurus glaucus* (Mull. & Henle)
Echthrogaleus denticulatus
*Isurus glaucus* (Mull. & Henle)
Anthosoma crassum
Caligus coryphaenae
Echthrogaleus coleoptratus
Elytrophora hemiptera
*Isurus nasus* (Bonnaterre)
Gangliopus pyriformis
*Isurus oxyrhynchus* Rafinesque
Anthosoma crassum
Dinemoura latifolia
Echthrogaleus coleoptratus
Nemesis lamna
Pandarus smithii
*Johnius angolensis* (Linn.)
Sciaenophilus benedeni
*Johnius diacanthus* (Lacepede)
Sciaenophilus benedeni
*Johnius hololepidotus* (Lacepede)
Sciaenophilus benedeni
*Katsuwonus pelamis* (Linn.)
Caligus bonito
Caligus coryphaenae
Caligus euthynnus
Caligus productus
Pseudocycnus appendiculatus
*Katsuwonus vagans*=*Euthynnus vagans* (Lesson)
Caligus productus
*Labeo forskali*
Sciaenophilus pharaonis
*Lagocephalus inermis* (Schlegel)
Caligus lagocephali
Lepeophtheirus lagocephali
Taeniacanthus lagocephali
*Lagocephalus laevigatus* Gill=*Gastrophysus laevigatus* Blk.
Taeniacanthus lagocephali
*Lamna cornubica* Cuv.=*Isurus nasus* (Bonnaterre)
Anthosoma crassum
Echthrogaleus coleoptratus

*Lamna ditrophis* Hubbs & Follet
Dinemoura latifolia
Echthrogaleus coleoptratus
*Lamna nasus* (Bonnaterre)=*Isurus nasus* (Bonnaterre)
Anthosoma crassum
Dinemoura latifolia
Echthrogaleus coleoptratus
Nemesis lamna
Pandarus cranchii
*Lampugus punctulatus* Cuv. & Val.=*Coryphaena equisetis* Linn.
Euryphorus nordmanni
*Lates calcarifer* (Bloch)
Caligus diaphanus
Lernanthropus latis
*Lates niloticus* Cuv. & Val.
Sciaenophilus pharaonis
*Leiognathus daura* (Cuv.)
Lernanthropus leiognathi
*Leiognathus ruconius* Ham.-Buch.=*Secutor ruconius* (Ham.-Buch.)
Lernanthropus leiognathi
*Lethrinus rhodopterus* Blk.
Lernanthropus lativentris
*Lhotskia gavialoides* (Castelnau)
Bomolochus bellones
Caligodes laciniatus
*Eulamia falciformis* (Mull. & Henle)
Pandarus cranchii
*Eulamia floridanus*
Echthrogaleus denticulatus
Pandarus cranchii
Pandarus smithii
*Eulamia obscurus* (Le Sueur)
Pandarus cranchii
Pandarus smithii
*Euplatygaster indica* (Swainson)=*Ilisha melanostoma* (Schn.)
Clavellisa ilishae
*Euthynnus affinis* (Cantor)
Caligus amblygenitalis
Caligus asymmetricus
Caligus bonito

Caligus coryphaenae
Caligus euthynnus
Caligus productus
Caligus savala
Pseudocycnus appendiculatus

*Euthynnus alleteratus* (Rafinesque)=*Euthynnus affiinis* (Cantor)
Caligus asymmetricus
Caligus bonito
Caligus coryphaenae
Caligus euthynnus
Caligus infestans
Pseudocycnus appendiculatus

*Euthynnus lineatus*
Caligus bonito
Caligus productus

*Euthynnus pelamis* (Linn.)=*Katsuwonus pelamis* (Linn.)
(see *K. pelamis*)

*Euthynnus yaito* Kishinouye=*Euthynnus affinis affiinis* (Cantor)
Caligus asymmetricus
Caligus coryphaenae
Pseudocycnus appendiculatus

*Fistularia petimba* Lacepede
Pseudocaligus fistulariae

*Fistularia villosa* Kluzinger
Pseudocaligus fistulariae

*Galeocerdo cuvieri* (Le Sueur)=*Galeocerdo arcticus* (Faber)
Alebion crassus
Eudactylina pusilla
Kroyeria dispar
Nesippus tigris
Pandarus cranchii

*Galeorhinus australis* (Macleay)
Dinemoura latifolia

*Galeus glaucus* Roule=*Glyphis glaucus* (Linn.)
Kroyeria gracilis

*Gastrophysus lunaris* (Bloch)
Pseudocaligus laminatus

*Gaterin lineatus* (Linn.)
Caligus savala

*Gazza minuta* (Bloch)
Nothobomolochus quadriceros
Proclavellodes pillaii
*Gerres filamentosus* Cuv.
Lernanthropus triangularis
Nothobomolochus gerresi
*Gnathonodon speciosus* (Forsk)=*Caranx speciosus* Ogilby
Lernaeenicus longiventris
*Goniistius zonatus* Gill
Lepeophtheirus goniistii
*Grammatorcycnus bilineatus* Gill
Caligus corphaenae
Caligus asymmetricus
*Gymnosarda alleterata* Cunningham=*Euthynnus affinis* (Cantor)
Caligus bonito
*Gymnosarda pelamis* Jordan & Evermann=*Katsuwonus pelamis* (Linn.)
Caligus bonito
*Haemulon plumieri* (Lacepede)
Lernaeolophus sultanus
*Hapalogenys mucronatus* Gunther
Caligus annularis
*Hemigaleus balfouri* Day
Tripaphylus hemigalei
*Lichia amia* Cuv. & Val.=*Hypocanthus amia* (Linn.)
Nemesis lamna
*Lithognathus mormyrus* (Linn.)
Lernaeolophus sultanus
*Lutianus griseus* (Blk)=*Lutianus argentimaculatus* (Forsk.)
Caligus bonito
*Lutianus malabaricus* (Schn.)
Caligus rotundigenitalis
*Lutianus novemfasciatus* (Gill)
Caligus bonito
*Lutianus sanguineus* (Cuv.)
Lernanthropus brevicephalus
*Lutianus waigiensis* (Quoy & Gaimard)
Aethon globosus
*Maena vulgaris* Cuv.
Lernaeolophus sultanus

*Makaira indica* (Cuv.)
Gloiopotes huttoni
Gloiopotes watsoni
Pennella biloba
*Makaira mazara* La Moule=*Makaira nigricans* Lacepede
Gloiopotes huttoni
Gloiopotes watsoni
*Makaira mitsukurii* (Jordan & Snyder)=*Tetrapturus audax* Philippi
Elytrophora indica
Gloiopotes huttoni
*Makaira nigricans* Lacepede
Gloiopotes watsoni
*Marlina zealandica*=*Tetrapturus audax* Philippi
Gloiopotes huttoni
*Megalaspis cordyla* (Linn.)
Bomolochus megaceros
Caligus cordyla
Caligus robustus
Lernanthropus corniger
*Megalops cyprinoides* (Broussonet)
Lernanthropus cadenati
*Mesoprion phaiotaeniatus* Blk.
Lernanthropus lativentris
*Mobula diabolus* (Shaw)
Eudactylina olivieri
Pupulina brevicauda
Pupulina minor
*Mobula giornae*
Pupulina brevicauda
*Mobula lucasana* Beebe & Tee-Van
Pupulina brevicauda
Pupulina minor
*Monotretus cutcutia* (Ham.-Buch.)
Hatschekia pholas
*Mugil cephalus* Linn.
Caligus bonito
Lernaeenicus longiventris
Lernaeolophus sultanus
Lernanthropus shishidoi

*Muraenesox cinereus* (Forsk.)
Pseudocongericola cheefoonensis
*Muraenesox talabonoides* Blk.
Pseudocongericola cheefoonensis
*Mustelus canis* (Mitchill)
Alebion gracilis
*Mustelus mustelus* (Linn.)
Anthosoma crassum
*Narcine timlei* (Bl. & Schn.)
Pseudocharopinus narcinae
Taeniacanthus narcini
*Naucrates ductor* (Linn.)
Caligus productus
*Negaprion brevistrostris* (Poey)
Kroyeria spatulata
Paralebion elongatus
*Nematalosa nasus* (Bloch)
Lernanthropus rubiginosus
*Nemipterus furcosus* (Val.)
Lernanthropus nemipteri
*Nemipterus japonicus* (Bloch)
Clavellisa bilobata
Hatschekia foliata
Holobomolochus nemipteri
Lernaeenicus nemipteri
*Nemipterus marginatus* (Cuv. & Val.)
Lernaeenicus nemipteri
*Neomaenis aya*
Thysanote longimanus
*Neothunnus albacora* Nicols & La Monte=*Germo albacora* (Lowe)
Caligus coryphaenae
Caligus productus
Caligus quadratus
Elytrophora hemiptera
*Neothunnus macropterus* (Schlegel)
Caligus coryphaenae
Caligus robustus
Caligus quadratus
Euryphorus nordmanni

*Netuma macrocephalus*
Hermilius pyriventris
*Odontaspis ferox* (Risso)
Nemesis lamna
*Oligoplites saurus* (Bl. & Schn.)
Caligus bonito
*Opisthopterus tardoore* (Cuv.)
Lernanthropus opisthopteri
*Orcynus thynnus* Kitahara=*Thunnus thynnus* (Linn.)
Brachiella thynni
*Ostracion punctatus* Day
Peniculisa furcata
*Otolithus argenteus* Cuv.
Brachiella albida
Brachiella otolithi
Lernanthropus otolithi
*Otolithus maculatus* (Cuv.)
Caligus annularis
Lernanthropus otolithi
*Pagrosomus major* (Temm. & Schl.)
Caligus laticaudus
Lernanthropus shishidoi
*Pagrosomus unicolor*=*Pagrosomus major* (Temm. & Schl.)
Lernanthropus shishidoi
*Palinurichthys perciformis* (Mitchill)=*Coryphaena perciformis*
Lernaeenicus longiventris Mitchill
*Pampus argenteus* (Euphrasen)=*Stromateus argenteus* Euphrasen
Caligus multispinosus
Nothobomolochus triceros
Synestius caliginus
*Paralabrax clathratus*
Caligus productus
*Paralabrax maculatofasciatus*=*Paralabrax fasciatus* Blk.
Caligus productus
*Parastromateus niger* (Bloch)
Bomolochus megaceros
Lernaeenicus stromatei
Lernaeopoda stromatei
Lernanthropus koenigii
Synestius caliginus

Thysanote appendiculata

*Parathunnus macropterus*=*Neothunnus macropterus* (Schlegel)

Caligus quadratus

*Parathunnus obesus* Frade=*Germo obesus* (Lowe)

Caligus coryphaenae

Elytrophora indica

*Parathunnus sibi* (Schlegel)=*Germo obesus* (Lowe)

Caligus coryphaenae

*Paratractos crysos*=*Caranx crysos* Mitchill

Caligus robustus

*Parexocoetus brachypterus* Richardson

Pennella robusta

*Pastinachus sephen* (Forsk.)=*Dasyatis sephen* (Forsk.)

Trebius sepheni

*Pelamys sarda* Cuv. & Val.=*Sarda sarda* (Bloch)

Caligus bonito

*Phycis floridanus*=*Urophycis floridanus* (Bean & Dresel)

Tuxophorus caligodes

*Pisodonophis cancrivorus* (Richardon)

Pseudotaeniacanthus longicauda

*Platax teira* (Forsk.)

Anuretes anomalus

Heniochophilus branchialis

Heniochophilus indicus

Mappates plataxus

Pseudanuretes schmidti

*Platybelone argalus*=*Belone argalus* Le Sueur

Bomolochus bellones

Caligodes laciniatus

Lernanthropus tylosuri

Nothobomolochus gibber

*Plectropoma cyanostigma* Blk.

Caligus phipsoni

*Pogonias cromis* (Linn.)

Caligus productus

Lernaeenicus longiventris

*Pollachius virens* (Linn.)

Alebion gracilis

*Polynemus heptadactylus* Cuv.

Caligus laticaudus

Lernanthropus trifoliatus

*Polynemus plebeius* (Broussonet)

Caligus phipsoni

Parapetalus hirsutus

Thysanote eleutheronemi

*Polynemus sextarius* Bloch

Lernanthropus trifolialus

*Polynemus tetradactylum* (Shaw)

Caligus phipsoni

Lernaeenicus polynemi

Lernanthropus lappaceus

Lernanthropus trifoliatus

*Pomadasys maculatus* (Bloch)

Lernanthropus abitocephalus

*Pomatomus saltatrix* Linn.

Brachiella thynni

Caligus bonito

Lernaeenicus longiventris

*Priacanthus hamrur* (Forsk.)

Aethon priacanthi

Caligus hamruri

Caligus priacanthi

Lernaeolophus sultanus

*Prionace glauca* Roule=*Glyphis glaucus* (Linn.)

Dinemoura latifolia

Echthrogaleus coleoptratus

Echthrogaleus denticulatus

Gangliopus pyriformis

Pandarus satyrus

Phyllothereus cornutus

*Pristidion gracilis*=*Pristidion gracile* Goode & Bean

Charopinopsis quaternia

*Pristipomoides typus* Blk.

Lernanthropus pristipomoides

*Promicrops itaina*?

Tuxophorus caligodes

*Promicrops lanceolatus* (Bloch)

Lepeophtheirus goniistii

*Psenes indicus* (Day)

Bomolochus multiceros

*Psettodes erumei* (Bloch)
Protochondracanthus alatus
Protochondracanthus trilobatus
*Pseudarius jatius* (Ham. Buch)=*Tachysurus jatius* (Day)
Caligus arii
Hermilius helleri
Lepeophtheirus longipalpus
*Pseudarius platystomus* (Day)=*Tachysurus platystomus* (Day)
Hermilius pyriventris
*Pseudopristipoma nigra*
Lepeophtheirus latigenitalis
*Pseudorhombus arsius* (Ham.-Buch.)
Heterochondria longa
Heterochondria pillaii
*Pseudorhombus triocellatus* (Bl. & Schn.)
Heterochondria longa
*Pseudosciaena albida* Blk.
Brachiella albida
*Pseudupeneus chrysopleuron*=*Upeneus chrysopleuron*
Lepeophtheirus gonistii (Temm. & Schl.)
*Pterois miles* (Bennett)
Caligus pteroisi
Parataeniacanthus miles
*Pterois russellii* Bennett
Caligus russellii
*Pterolamiops longimanus*?
Pandarus cranchii
*Rachycentron canadus* (Linn.)
Caligus coryphaenae
Lepeophtheirus spinifer
Parapetalus occidentalis
Tuxophorus caligodes
*Rastrelliger kanagurta* (Cuv.)
Caligus kanagurta
Lernaeenicus sayori
Lernanthropus corniger
Nothobomolochus kanagurta
Orbitacolax aculeatus
Pumiliopes jonesi
Thysanote rastrelligeri

*Remilegia australis* (Bennett)
Lepeophtheirus crassus
*Rhabdosargus sarba* (Forskal)
Caligus cossacki
Caligus laticaudus
*Rhincodon typus* Smith
Echthrogaleus pectinatus
*Rhinoptera javanica* Mull. & Henle
Trebius exilis
Trebius javanicus
*Rhizoprionodon acutus* (Ruppell)
Eudactylina aspera
Kroyeria spatulata
Pseudopandarus longus
*Rhombochirus osteochir*=*Echeneis osteochir* Cuv.
Lepeophtheirus crassus
*Rhynchobatus djedensis* (Forsk.)
Nesippus vespa
*Rhynchobatus schlegelii* (Richardson)
Caligus quadratus
*Ruvettus pretiosus* Cocco
Dissonus ruvetti
*Sarda chilensis* Steindachner & Doderlein=*Sarda orientalis* (Temm. & Schl.)
Caligus bonito
*Sarda orientalis* (Temm. & Schl.)
Caligus asymmetricus
Caligus bonito
Caligus coryphaenae
*Sarda sarda* (Bloch)
Caligus bonito
Caligus productus
Pseudocycnus appendiculatus
*Sarda velox* Meek & Hildebrand=*Sarda orientalis* (Temm. & Schl.)
Caligus bonito
*Sardina pilchardus* (Walbaum)
Peroderma cylindricum
*Sardinella albella* (Val.)
Peroderma cylindricum
Pumiliopsis sardinellae

*Sardinella eba* Val.
Peroderma cylindricum
*Sardinella fimbriata* (Val.)
Lernanthropus oblongus
Pseudopetalus formicoides
*Sardinella leiogaster* (Blk.)=*Sardinella sirm* (Walbaum)
Pumiliopsis plautus
*Sardinella sirm* (Walbaum)
Pumiliopsis plautus
*Saurida tumbil* (Bloch)
Abasia platyrostris
Lernanthropus gibbosus
Parataeniacanthus longicervis
Taeniacanthus longicaudus
*Scatophagus argus* (Linn.)
Caligus rotundigenitalis
*Sciaena albida* Day=*Johinius coibor* (Ham.-Buch.)
Peniculus sciaeni
*Sciaena aquila* Risso=*Pseudosciaena aquila* Blk.
Brachiella thynni
Sciaenophilus tenuis
*Sciaena glaucus* Day=*Johnius dussumieri* (Cuv.)
Brachiella albida
Caligus sciaenae
Lernanthropus sciaeni
*Sciaena semiluctosa* Day=*Johnius semiluctosus* (Cuv. & Val.)
Sciaenophilus pharaonis
*Sciaena rubra* Forsk.
Brachiella thynni
*Scoliodon palasorrah* (Cuv.)
Pseudopandarus gracilis
*Scoliodon sorrakowah* (Cuv.)
Kroyeria minuta
Kroyeria spatulata
Pseudopandarus longus
*Scoliodon terrae-novae* (Richardson)
Eudactylina aspera
Kroyeria gracilis
Kroyeria spatulata
Paralebion elongatus

*Scoliodon walbeehmi* (Blk.)
Lernaeopoda scoliodontis
*Scomber mecrolepidotus* Ruppell=*Rastrelliger kanagurta* (Cuv.)
Peniculus scomberi
*Scomberomorus cavalla* Cuv.=*Scomberomorus maculatus* (Mitehill)
Brachiella thynni
Caligus bonito
Caligus productus
Charopinopsis quaternia
*Scomberomorus commersoni* (Lacepede)
Caligus infestans
Lernaeenicus alatus
Pseudocycnus armatus
*Scomberomorus maculatus* (Mitchill)
Caligus bonito
Caligus productus
Lernaeenicus longiventris
*Scomberomorus queenslandicus* Munro
Pseudocycnus armatus
*Scomberomorus sierra*
Caligus productus
*Scorpaena guttata* Girard
Lepeophtheirus brachyurus
*Secutor insidiator* (Bloch)
Lernanthropus secutoris
*Selar kalla* (Cuv.)
Caligus bicycletus
*Selar malam* Blk.
Pennella selaris
*Selar mate* (Cuv.)
Caligus robustus
*Selaroides leptolepis* (Cuv.)
Bomolochus selaroides
Lernanthropus alatus
*Seriola dorsalis* (Gill)
Caligus coryphaenae
Caligus productus
*Serranus cabrilla* (Linn.)
Lernaeolophus sultanus

*Serranus scriba* (Linn.)
Lernaeolophus sultanus
*Setipinna phasa* (Ham.-Buch.)
Clavellisa phasa
*Siganus fuscescens* Jordan & Fowler
Lepeophtheirus goniistii
*Sillago sihama* (Forsk.)
Lernanthropus sillaginis
*Solea vulgaris* Cuv.
Caligus diaphanus
*Sparus longispinis*
Lernanthropus chrysophrys
*Sparus macrocephalus* (Basilewsky)
Caligus epinepheli
Lernanthropus chrysophrys
Lernanthropus shishidoi
*Sphaeroides inermis*=*Lagocephalus inermis* (Schlegel)
Caligus coryphaenae
*Sphaeroides spadiceus* Jordan & Snyder
Taeniacanthus lagocephali
*Sphyraena acutipinnis* Day
Caligus clavatus
*Sphyraena argentea* (Girard)
Caligus productus
*Sphyraena barracuda* (Walbaum)
Caligus lobodes
*Sphyraena jello* Cuv.
Caligus cornutus
Nothobomolochus denticulatus
*Sphyraena obtusata* Cuv.
Caligus cornutus
Caligus clavatus
Lernanthropus sphyraeni
*Sphyraena pinguis* (Gunther)
Lernanthropus sphyraeni
*Sphyrna diplana*
Alebion crassus
Pandarus satyrus
*Sphyrna lewini* Dumeril=*Sphyrna zygaena* (Linn.)
Alebion crassus

Eudactylina aspera
Pandarus cranchii

*Sphyrna mokarran* (Ruppell)
Eudactylina pollex
Kroyeria gemursa

*Sphyrna zygaena* (Linn.)
Alebion crassus
Echthrogaleus denticulatus
Kroyeria echinata
Kroyeria gracilis
Kroyeria sphymae
Nemesis versicolor
Pandarus cranchii
Pandarus satyrus
Pandarus smithii

*Squalus acanthias* Linn.
Alebion gracilis
Caligus coryphaenae
Echthrogaleus coleoptratus

*Stolephorus tri* Blk.
Cardiodectes anchorellae

*Stromateus paru* Bloch=*Parastromateus niger* (Bloch)
Lernanthropus koenigii

*Stromatoides argenteus*=*Stromateus argenteus* (Euphrasen)
Caligus multispinosus

*Stromatoides sinensis* Day=*Stromateus chinensis* (Euphrasen)
Bomolochus megaceros
Synestius caliginus

*Strongylura anastomella*=*Tylosurus anastomella* (Cuv. & Val.)
Bomolochus bellones
Lernanthropus tylosuri

*Strorgylura exilis* (Girard)
Lernanthropus tylosuri

*Strongylura incisa*=*Tylosurus leiurus* (Blk.)
Bomolochus bellones
Lernanthropus tylosuri

*Strongylura leiura* Fowler=*Tylosurus leiurus* (Blk.)
Bomolochus bellones
Caligodes laciniatus
Lernanthropus tylosuri

Nothobomolochus digitatus

*Strongylura marina* (Walbaum)

Bomolochus bellones

Lernanthropus tylosuri

*Stronglyura senegalensis* Monod=*Belone senegalesis* Val.

Bomolochus bellones

*Strongylura strongylura* Fowler=*Strongylura strongylurus* (Van Hass)

Bomolochus bellones

Lernanthropus tylosuri

Nothobomolochus digitatus

*Strongylura timuca* (Walbaum)

Bomolochus bellones

Lernanthropus tylosuri

*Strongylura urvillii* (Val)

Bomolochus bellones

Lernanthropus tylosuri

*Synodus indicus* (Day)

Abasia platyrostris

Metataeniacanthus synodi

*Tachysurus feliceps* (Val.)

Hermilius pyriventris

*Tetrapturus audax* Philippi

Gloiopotes huttoni

Gloiopotes watsoni

*Tetrapturus marlina*=*Makaira indica* (Cuv.)

Gloiopotes watsoni

*Tetrapturus mitzukuri* Jordan & Snyder=*Tetrapturus audax* Philippi

Gangliopus pyriformis

Gloiopotes huttoni

Gloiopotes watsoni

*Tetrodon calanara* Ruppell

Lepeophtheirus brachyurus

*Tetrodon hypselogeneion* Blk.

Lepeophtheirus brachyurus

*Tetrodan oblongus* (Bloch)

Pseudocaligus parvus

Taeniacanthus tetradonis

*Terrodon stellatus* Bl. & Schn.
Dissonus spinifer
Hatschekia pholas
Lepeophtheirus brachyurus
*Therapan jarbua* (Forsk.)
Peniculus theraponi
*Therapon theraps* Cuv. & Val.
Bomolochus megaceros
*Thrissocles hamiltonii* (Gray)
Cardiodectes anchorellae
Lernanthropus chirocentrosus
*Tarissocles malabarica* (Bloch)
Clavellisa obchordata
*Thunnus alalunga* (Bonnaterre)
Pseudocycnus appendiculatus
*Thunnus albacora* Clark=*Germo albacora* (Lowe)
Pseudocycnus appendiculatus
*Thunnus macropterus* Schlegel=*Germo albacora* (Lowe)
Brachiella thynei
*Thunnus obesus* Lowe=*Germo obesus* (Lowe)
Pseudocycnus appendiculatus
*Thunnus orientalis* Schlegel=*Thunnus thynnus* (Linn.)
Elytrophora hemiptera
*Thunnus pelamys* (Cuv.)
Caligus productus
*Thunnus thynnus* (Linn.)
Brachiella thynei
Caligus bonito
Caligus coryphaenae
Pseudocycnus appendiculatus
*Trachynotus blochi* (Lacepede)
Caligus indicus
Lernanthropodes trachinoti
*Trachynotus cavolinus* (Linn.)
Tuxophorus caligodes
*Triakis scyllium* Mull. & Henle
Pseudopandarus gracilis
*Trichiurus haumela* (Forsk.)
Brachiella trichiuri
Caligus longicaudus

Caligus longipedis
Caligus savala
Caligus uruguayensis
Lernanthropus forficatus
Peniculus trichiuri

*Trichiurus lepturus* Linn.=*Trichiurus haumela* (Forsk.)
Caligus uruguayensis

*Trichiurus muticus* Richardson
Peniculus trichiuri

*Trichiurus savala* Cuv.
Brachiella trichiuri
Caligus savala
Caligus uruguayensis
Lernanthropus forficatus
Nothobomolochus trichiuri
Peniculus trichiuri

*Trigla capensis* Cuv.
Medesicaste penetrans

*Tylosurus acus*=*Strongylura acus* (Lacepede)
Bomolochus bellones
Caligodes laciniatus
Caligus tylosuri
Lernanthropus tylosuri
Nothobomolochus gibber
Tuxophorus caligodes

*Tylosurus chorani* Ruppell=*Tylosurus crocodilus* (Le Sueur)
Caligodes laciniatus
Lernanthropus tylosuri

*Tylosurus contraini* Cocco
Caligodes laciniatus

*Tylosurus crocodilus* (Le Sueur)
Bomolochus bellones
Caligodes laciniatus
Caligus malabaricus
Caligus tylosuri
Lernanthropus tylosuri
Nothobomolochus digitatus
Nothobomolochus gibber

*Tylosurus giganteus* (Schlegel)
Nothobomolochus gibber

*Tylosurus leiurus* (Blk.)
Caligodes laciniatus
*Tylosurus marinus*=*Strongylura marina* (Walbaum)
Lernaeolophus sultanus
Tuxophorus caligodes
*Tylosurus punctulatus* (Gunther)
Lernanthropus tylosuri
Nothobomolochus digitatus
*Tylosurus strongylurus* (Van Hass.)
Caligodes laciniatus
*Umbrina cirrosa* Vinciguerra=*Sciaena cirrosa* Linn.
Sciaenophilus tenuis
*Upeneus vittatus* (Forsk.)
Lernaeopoda upenei
*Verrunculus polylepos*
Caligus productus
*Vinciguerria lucetia* (Garman)
Cardiodectes krishnai
*Xiphias gladius* Linn.
Gloiopotes huttoni
Pennella instructa
*Xiphias zeugopteri*
Gloiopotes huttoni
Gloiopotes watsoni
*Zonichthys nigrofasciata* (Ruppell)
Caligus parapetalopsis

# ADDENDUM

The manuscript of this work was submitted for publication in November, 1979. Since then several important works on copepod parasites of fishes got published. The present work will, therefore, be somewhat out of date by the time it reaches interested readers. I am adding brief notes on the more important aspects which is all that is possible at this stage.

P. 28 CLASSIFICATION

The Sarsian classification relied mainly on the shape of the body. This system was replaced by several others giving emphasis to the nature of the mouth parts. The latest is that by Kabata (1979) which divided Copepoda into seven suborders namely, Calanoida, Harpacticoida, Monstrilloida, Mesophrioida, Cyclopoida, Poecilostomatoida and Siphonostomatoida. Stock (1981) has already expressed some disagreement with Kabata's proposed classification. Without taking sides in this continuing controversy I propose the following classification to replace the one given in this work.

Order COPEPODA
Suborder POECILOSTOMATOIDA
Family BOMOLOCHIDAE
Family TAENIACANTHIDAE
Family CHONDRACANTHIDAE
Family SHIINOIDAE
Suborder SIPHONOSTOMATOIDA
Family CALIGIDAE
Family EURYPHORIDAE
Family DISSONIDAE
Family TREBIIDAE
Family PANDARIDAE
Family LERNANTHROPIDAE
Family EUDACTYLINIDAE
Family KROYERIIDAE
Family PSEUDOCYCNIDAE
Family DICHELESTHIIDAE
Family HATSCHEKIIDAE
Family PENNELLIDAE
Family LERNAEOPODIDAE
Family SPHYRIIDAE

In the present work I have accepted a few subfamilies and also proposed a few. The recent opinion (Kabata, 1979) is that at the present state of our knowledge it is not advisable to divide families. This opinion is apparently correct since the division of Caligidae into subfamilies Caliginae, Lepeophtherinae and Anuretinae is arbitrary.

P. 6 MORPHOLOGY

Kabata (1979) published a detailed discussion on the morphology of parasitic copepods emphasising the impact of parasitism. He also discussed in detail the morphology and homology of the various appendages.

P. 30 BOMOLOCHIDAE

During the last five years Cressey published several valuable works on this family. He created a few new genera and redistributed a few species. Balaraman (1983) published a general discussion on this family.

**Tegobomolochus** Izawa, 1976.

In addition to the curious shape of its body this parasite has a sclerotised plate on its antennule, an unusually well developed paragnath and a greatly reduced maxilliped. This parasite was collected from the nasal fossae of *Psedupeneus* at Japan and has not been recorded from the Indian region.

**Boylea** Cressey, 1977.

This genus can be distinguished by two characters : The fifth seta on its antennule is plumose like the adjacent ones but is proximally swollen and highly sclerotised. The outer distal part of the caudal ramus is prolonged into a spine. Balaraman (1983) recently recorded this genus from Kerala.

**Unicolax** Cressey & Cressey, 1980b.

This genus has the fourth seta on its antennule modified into a process as in *Bomolochus*. According to the authors the process

is sharply curved and highly sclerotised while in *Bomolochus* it is nearly straight and poorly sclerotised. In the male of *Unicolax* the rami of the first leg are flattened as in the female but are narrow and quite different from those of the female in *Bomolochus*.

Cressy & Cressey described three new species and transferred *Parabomolochus anonymous* Vervoort, 1965, and *Parabomolochus mycterobius* Vervoort, 1965, to this genus. *Unicolax* was recently recorded by Balaraman (1983) from Kerala.

**Neobomolochus** Cressey, 1981.

This genus differs from all the known bomolochids in the combination of two characters. The caudal ramus has a single enlarged terminal seta. The second segment of the endopod of the fourth leg lacks inner seta. This genus has not been collected from the Indian waters.

**Holocolax** Cressey, 1982.

This genus was created to accommodate *Holobomolochus nemipteri* Pillai, 1973, (see p. 49) and two new species, *Holocolax longisetus* and *Holocolax russelli*, all parasites of *Nemipterus*. This genus can be distinguished by the armature of the third endopod segment of the third leg which includes one spine and three setae. The usual number in other bomolochids is two spines and two setae.

**Tricolax** Balaraman, 1983.

In this genus the fourth, fifth and sixth setae of the antennule are modified. The fourth seta is converted into a short highly sclerotised and incurved process and the fifth and sixth into long nearly straight and poorly sclerotised processes. The single known species was collected from Kerala.

P. 83. **Pseudorbitacolax** Pillai.

Cressey & Cressey (1980a) redefined this genus and transferred *Orbitacolax nudus* Cressey & Boyle, 1973, to this genus. This transfer is suggested in this work (see p. 84).

P. 87. **Pumiliopes** Shen.

Cressey & Cressey (1980a) redefined this genus and made *Pumiliopes capitulus* Cressey & Boyle, 1973, a synonym of *Pumiliopes jonesi* (Bennet).

P. 89. **Pumiliopsis** Pillai.

Cressey & Cressey (1980a) redefined this genus and made *Pumiliopsis emarginatus* Cressey & Boyle, 1973, a synonym of *Pumiliopsis sardinellae* (Bennet).

P. 96 TAENIACANTHIDAE

To the genera mentioned in the discussion on this family should be added *Clavisodalis* Humes, 1970, *Echinoscius* Humes & Cressey, 1961, and *Echiniurus* Humes & Cressey, 1961. These three genera include parasites of sea urchins. Balaraman (1983) published a general discussion on this family.

P. 98. **Taeniacanthus** Sumpf.

Umadevi & Shyamasundari (1980) described *Irodes anguillaris* n.sp. This should be transferred to *Taeniacanthus* as *Irodes* is a synonym of *Taeniacanthus* (see p. 98).

P. 109. **Parataeniacanthus** Yamaguti.

Umadevi & Shyamasundari (1980) described *Parataeniacanthus russelli* n.sp. This species appears to be a *Taeniacanthus.*

P. 115. **Metataeniacanthus** Pillai.

Cressey & Cressey (1979) described nine new species of *Matataeniacanthus*, redescribed the type species, *M. synodi* Pillai, redefined the genus and provided a key for the identification of the ten known species. All the species are parasites of lizard fishes.

*M. vulgaris* Cressey & Cressey, *M. epigri* Cressey & Cressey, *M. gibbsi* Cressey & Cressey, *M. nudus* Cressey & Cressey and

*M. aquilonius* Cressey & Cressey were collected from the Indian waters.

P. 118. **Pseudotaeniacanthus** Yamaguti & Yamasu.

Umadevi & Shyamasundari (1980) described *Pseudotaeniacanthus muraenesocis* n.sp. from Waltair increasing the number of known species to five including the unnamed one. All the parasites are from marine eels. Two of these occur in Indian waters.

P. 123 CHONDRACANTHIDAE

Balaraman, Prabha & Pillai (1979) published full descriptions of *Praecidochondria galatheae* Kabata, 1968a, and *Praecidochondria setoensis* Izawa, 1975, based on material collected in the Kerala waters. These are new additions to the Indian fauna.

SHIINOIDAE

Balaraman, Prabha & Pillai (in press) described *Shiinoa occlusa* Kabata, 1968b, *S. elegata* Cressey, 1976 and *S. rostrata* n.sp. collected from Kerala waters. This family is an addition to the Indian fauna.

P. 147, 149 PANDARIDAE

**Dinemoleus** Cressey & Boyle, 1978.

This genus is intermediate in characters between *Dinemoura* and *Demoleus*. It differs from *Dinemoura* in the two-segmented rami of the second and third legs. In *Dinemoura* these rami are three-segmented.

P. 230 CALIGIDAE

Kabata (1979) has given a good discussion of this family. Prabha (1983) has published a general discussion of the family.

**Pseudechetus** Prabha & Pillai, 1979.

This genus is closest to *Parechetus* Pillai but differs in having two pairs of digitiform processes on the genital segment (one pair of

petaloid lobes in *Parechetus*) and a single pair of identical processes on the abdomen (abdomen flattened and laterally expanded in *Parechetus*).

**Kabataella** Prabha & Pillai (in press)

This copepod is different from all other caligids in the absence of frontal plates and membranous flange. The first three pairs of legs show great modification and reduction especially in the absence of membranous flange on the third legs. The shape of the body is unique. *Kabataella* is closest to *Lepeophtheirus*.

P. 233. **Caligus** Muller

Cressey & Cressey (1980b) published short descriptions of the following species of *Caligus*.

*C. amblygenitalis* Pillai
*C. asymmetricus* Kabata
*C. biseriodentatus* Shen
*C. bonito* Wilson
*C. coryphaenae* Stp. & Lutk.
*C. cybii* Bassett-Smith
*C. diaphanus* Nordmann
*C. infestans* Heller
*C. productus* Dana
*C. savala* Gnanamuthu

Kabata (1979) has published full descriptions of :

*C. bonito* Wilson
*C. coryphaenae* Stp. & Lutk.
*C. diaphanus* Nordmann
*C. productus* Dana

P. 247. **Caligus auxisi** Pillai

Cressey & Cressey (1980b) made this species a synonym of *C. biseriodentatus* Shen alleging that *C. auxisi* represents the adult of *C. biseriodentatus*. A comparison of the illustrations of these two

species reveals differences which cannot be dismissed as indicating growth changes.

One of my students recently collected juveniles and adults of *Pseudopetalus caudatus* (Gnanamuthu). The juveniles resemble *C. biseriodentatus* in every detail. It is, therefore, evident that *C. biseriodentatus* represents the juvenile of *Pseudopetalus* and that *C. auxisi* is a valid species.

**Caligus benneti** Causey, 1953.

Prabha & Pillai (1983) described this species collected in the Kerala waters. This species is unique in having an abdomen which is longer than the rest of the body, very much as in *Sciaenophilus*. *C. benneti* is an addition to the Indian fauna.

P. 296. **Caligus holocentri** n.sp.

This species is a synonym of *C. alaihi* Lewis, 1968.

P. 321. **Caligus nengai** Rangnekar, Rangnekar & Murti.

The original description of this species is inadequate. The extremely elongated abdomen of its male indicates that *C. hilsae* Shen is a synonym of *C. nengai*. Pillai & Lalmohan (1967) have described *C. hilsae* in detail.

**Caligus reniformis** Prabha & Pillai, 1983.

This species has a transversely expanded genital segment which is broader than the cephalothorax and an abdomen nearly as long as the rest of the body. The absence of sternal fork easily distinguishes it. This is an addition to the Indian fauna.

P. 367 **Pseudocaligus**

In addition to the species mentioned in this work three more species namely, *P. indicus* Hameed, 1977, *P. subparvus* Hameed, 1977, and *P. smithi* Pillai, 1979, have been recorded from the Indian waters. *P. indicus* can be distinguished by the armature of the distal

segment of the first leg and the absence of the claw of the maxillule. *P. smithi* may be a synonym of *P. subparvus.*

P. 374 **Parapetalus**

P. 382. **Parapetalus orientalis** Stp. & Lutk.

Prabha & Pillai (1983) described the female in detail and the male for the first time.

P. 396 **Parechetus**

P. 398. **Parechetus carangis** (Bassett-Smith).

Prabha & Pillai (1983) redescribed the female and also the male for the first time. *P. constrictus* Kirtisinghe, 1964, has been made a synonym of *P. carangis.*

P. 403 **Abasia**

Cressey & Cressey (1979) described three new species of *Abasia.* This publication contains a redescription of *A. platyrostris* Pillai, a redefinition of the genus and a key to species. *Alicaligus* Shiino was made a synonym of *Abasia.* This was suggested in the present work (see p. 404).

**Caritus** Cressey, 1967

Prabha & Pillai (1983) described both sexes of *C. serratus* Cressey in detail based on collections made in Kerala. This genus is an addition to the Indian fauna.

P. 431 **Lepeophtheirus**

**Lepeophtheirus anguilli** Hameed, 1976.

This species closely resembles *L. plotosi* Barnard, 1948, especially in the shape of the genital segment. The available descriptions of both species lack details for coming to a conclusion. This is, however, an addition to the Indian fauna.

**Lepeophtheirus rotundigenitalis** Prabha & Pillai, 1983.

This species is apparently the same as *Anuretes rotundigenitalis* Hameed, 1976. I think this species belongs to *Lepeophtheirus.*

P. 453 **Anuretes**

**Anuretes rotundus** Prabha & Pillai, 1983.

The perfectly rounded body, the much reduced sternal fork and the long apical claw of the fourth leg distinguish this species. This is a new addition to the Indian fauna.

**Anuretes shiinoi** Prabha & Pillai, 1983.

This species closely resembles *Lepeophtheirus fallolunulus* Lewis, 1967, and may be its synonym.

P. 458 **Heniochophilus**

P. 462. **Heniochophilus indicus** Pillai.

Prabha & Pillai (1983) described the hitherto unknown male of this species.

P. 464 **Pseudanuretes**

**Pseudanuretes pomacanthodi** Prabha & Pillai, 1983.

This species closely resembles *P. fortipedis* Kabata, 1965, in the nature of the fourth leg which is a crucial specific character. In *P. fortipedis* the apical spine is naked but pectinate in *P. pomacanthodi.*

P. 700 DICHELESTHIIDAE *sensu lato*

Kabata (1979) revised Dichelesthiidae *sensu lato* and split it into six families. This necessitated a rearrangement of the genera. The following should be the arrangement of the genera included in the present work.

Family LERNANTHROPIDAE
**Lernanthropus**
**Paralernanthropus**
**Lernanthropodes**
**Norion**
**Aethon**
**Sagum**
Family DICHELESTHIIDAE
**Anthosoma**
Family EUDACTYLINIDAE
**Eudactylina**
**Eudactylinopsis**
**Bariaka**
**Nemesis**
Family KROYERIIDAE
**Kroyeria**
Family PSEUDOCYCNIDAE
**Pseudocycnus**
Family HATSCHEKIIDAE
**Hatschekia**
**Pseudocongericola**

P. 524 LERNANTHROPIDAE

With the removal of *Anthosoma* to Dichelesthiidae by Kabata (1979) family Lernanthropidae gets homogenity. Kabata placed in this family *Lernanthropus*, *Lernanthropodes*, *Norion*, *Aethon* and *Sagum*. According to him *Paralernanthropus* Hewitt, 1968, is not valid as the morphology of the third leg has no generic value. This may be true. But at present the shape of the egg tubes is used as a generic character. *Paralernanthropus* differs from *Lernanthropus* only in its coiled egg tubes. However, I have treated this genus as valid.

Jayasree (1983) published a discussion on this family.

P. 553 **Lernanthropus gibbosus** Pillai.

Cressey & Cressey (1979) published a brief description of *Lernanthropus temminckii* Nordmann based on collections made

from *Saurida tumbil* in the Indian waters. *L. gibbosus* collected from the same host and the same locality is apparently a synonym of this species.

P. 521 DICHELESTHIIDAE

*Anthosoma*, placed in Anthosomatidae, in this work, should come here. The only other dichelesthiid genus, *Dichelesthium*, has not been recorded from the Indian waters.

P. 629 EUDACTYLINIDAE

According to the revised arrangement of the genera this family will have *Eudactylina*, *Eudactylinopsis*, *Bariaka* and *Nemesis*. *Kroyeria* should come under Kroyeriidae.

P. 692 PSEUDOCYCNIDAE

Under Pseudocycnidae Kabata recognised three genera namely, *Cybicola*, *Pseudocycnus* and *Pseudocycnoides*. In this work I have recognised only *Pseudocycnus* as valid (Pillai, 1979). Kabata (1979) included *Bassettithia* in Hatschekiidae.

P. 700 HATSCHEKIIDAE

*Hatschekia* and *Pseudocongericola* placed under Dichelesthiidae in the present work should come here according to the new arrangement.

P. 714 LERNAEOCERIDAE

To satisfy nomenclatural priority Kabata (1979) replaced the family name Lernaeoceridae with Pennellidae. The following genera are represented in the Indian fauna :—*Lernaeenicus*, *Cardiodectes*, *Peniculus*, *Peniculissa*, *Lernaeolophus*, *Pennella* and *Peroderma*.

P. 748 LERNAEOPODIDAE

Kabata (1979) discussed in detail the morphology, phylogeny and taxonomy of this family.

P. 750 **Lernaeopoda**

P. 751 **Lernaeopoda upenei** Pillai, 1962.

According to Kabata (1979) this species is a *Neobrachiella* Kabata, 1979.

P. 753 **Lernaeopoda stromatei** Gnanamuthu, 1950.

This is the juvenile stage of *Thysanote appendiculata* Stp. & Lutk. as suggested in this work (see p. *755*). I have with me a series of the growth stages of the latter collected from *Parastromateus niger*.

P. 755 **Lernaeopoda scoliodontis** Kirtisinghe, 1964.

As the original description of this species was incomplete Kabata (1979) treated this as *species inquirende*. The description given in this work shows that it is a valid species.

P. 770 **Pseudocharopinus**

*Clavellopsis dasyaticus* Rangnekar, as shown in this work (see p. *776*) is a true *Pseudocharopinus*. It has priority over *P. dasyaticus* (Pillai). Hence I renamed *P. dasyaticus* (Pillai) as *P. kabatai*. But Kabata (1979) has already given this species the name *P. pillaii*. This should therefore be its correct name.

P. 758 **Thysanote**

**Thysanote polyfimbriata** Prabha & Pillai, 1981.

This species is characterised by highly branched processes on the maxilla and the hind end of the body. The processes are dichotomously branched thric and the end branched are short, with acute tip. This is a unique character.

**Thysanote nudibranchiata** Pillai, Prabha & Balaraman, 1982.

This species can be distinguished by the absence of processes on the maxillae. In this character it resembles *T gymnobranchiata* Kabata, 1968, and may be a synonym of the latter.

P. 781 **Brachiella**

Kabata (1979) concluded that *Brachiella thynni* Cuvier and probably *B. magna* Kabata, 1968, alone can remain in *Brachiella*. A vast majority of the other species now place in *Brachiella* should be removed to *Neobrachiella* Kabata, 1979.

**Brachiella cybii** Pillai, Prabha & Balaraman, 1982.

This species is a true *Brachiella*. It closely resembles *B. magna* Kabata and may be its synonym.

**Brachiella malabarica** Pillai, Prabha & Balaraman, 1982.

This species is a *Neobrachiella* closely resembling *N. lutiani* (Pillai) (=*Brachiella indica* Pillai, 1968, preoccupied) from which it differs in only minor characters. The main difference is the absence of a third pair of trunk processes.

**Clavella**

**Clavella ovata** Yamaguti, 1939.

The only species of *Clavella* hitherto recorded from the Indian waters is *C. uncinata* Muller. Kirtisinghe's record has not been confirmed. The present record of *C. ovata* Pillai *et al*, 1982 is hence significant.

P. 793 **Clavellisa**

It has been suggested in the present work (see p. *794*) that *Clavellisa ilishae* Pillai is a synonym of *C. hilsae* Tripathi, 1962, and *C. chordata* Pillai a synonym of *C. pellonae* Tripathi, 1982. Kabata (1979) expressed the same opinion and also commented that the material described by Pillai as *C. emarginata* may not belong to this species.

P. 803 **Isobranchia**

Pillai (1968) showed that *Isobranchia* Heegaard, 1947, is not a valid genus. Kabata (1979) accepted this suggestion. During the

present work it became evident that *Clavellisa appendiculata* Kirtisinghe is a synonym of *Isobranchia appendiculata* Heegaard. I, therefore, reversed by opinion and described this species as *Isobranchia appendiculata*, treating *Isobranchia* as valid.

Kabata (1979) observed on p. 332 that *Clavellopsis* has well developed posterior processes. On p. 348 Kabata says that Pillai proved to his satisfaction that *Isobranchia appendiculata* is a *Brachiella* (=*Neobrachiella*) as then constituted. This means that *Isobranchia appendiculata* is either a *Clavellopsis* or *Neobrachiella*. The male of *I. appendiculata* is clearly of the *Clavella* type. Though Kabata stated that further comments on *Clavellopsis* will be given at the appropriate place (p. 348) I could not find any. The taxonomy of the so called *Brachiella* and *Clavella* groups of lernaeopodids is confusing, at least to me. I suggest that the species under reference may be named *Clavellopsis appendiculata* Kirtisinghe.

P. 814 **Tripaphylus**

The type species, *T musteli* was described with the help of a decapitated specimen (vide Kabata, 1979). *T hemigalei* Kirtisinghe, 1964, was created to describe complete specimens. The post-cephalic parts of these two species are nearly identical. Hence the validity of *T hemigalei* can be confirmed only after the description of a complete specimen to *T musteli* becomes available.

P. 821 **References**

The year of publication of Heller's work on Copepoda is given as 1865 and 1868 in the present work. Heller first published his work on Copepoda in 1865 and reissued the same along with other fascicles in 1868. Hence the correct year of publication is 1865.

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# INDEX


Abasia 233, 403, 874
  platyrostris 404, 874
  pseudorostris 404,
  tripartitus 404
abitocephalus, Lernanthropus 527, 528
Acanthochondria 132
Acanthocolax 31
Achtheinus 171
aculeatus, Orbitacolax 80, 81, 83
acuta, Eudactylina 640
acutus, Caligus 353
  Holobomolochus 49
aesopus, Lepeophtheirus 433, 435
Aethon 521, 612, 876
  globosus 614
  priacanthi 614, 616
  quadratus 612
affinis, Caligus 353
afurcatus, Caligus 367
aggregatus, Nemesis 657, 658, 667, 670
akajei, Trebius 220
alaihi, Caligus 873
alalongae, Caligus 264
alata, Eudactylina 640, 651
alatus, Alebion 502
  Caligodes 407
  Lernaeenicus 717, 723
  Lernanthropus 528, 531
  Nesippus 179
  Protochondracanthus 127, 128
albida, Brachiella 781, 782
  Charopinopsis 778, 779
albidus, Holobomolochus 49
Alebion 479, 501
  alatus 502
  carchariae 502, 512
  crassus 502, 506
  difficilis 512
  echinatus 506
  elegans 502, 514
  fuscus 512
  gracilis 502, 510
  maculatus 502
  megacephalus 502
  spinosus 502
Alicaligus 403, 404, 874
aliuncus, Caligus 274
  Pupulina 423
alopiae, Bariaka 635, 636
alter, Mappates 467, 470
alveolaris, Caligus 290
amblygenitalis, Caligus 235, 239, 332
americanus, Gloiopotes 480
amplyfurcus, Caligus 314
Anaclavella 757
analogus, Orbitacolax 80
Anchistrotos 97, 121
  gobii 122
  moa 122
  sauridi 122
anchorellae, Cardiodectes 727
anchoviellae, Lernaeenicus 726
anguillaris, Irodes 870
anguilli, Lepeophtheirus 874
angulatum, Sagum 619, 620
annularis, Caligus 236, 241
anomalus, Anuretes 454, 456
anonymous, Parabomolochus 33
Anthosoma 519, 521, 876, 877
  crassum 522
Anthosomatidae 519, 877
Anuretes 451, 452, 453, 875
  anomalus 454, 456
  branchialis 459
  heckeli 453, 454
  menehune 454
  parvulus 454
  perplexus 454
  plectorhynchi 454
  quadrilaterus 454
  renalis 454
  rotundigenitalis 875
  rotundus 875
  serratus 454
  shiinoi 875
Anuretinae 450, 868
apodus, Pseudocaligus 368
appendiculata, Clavellopsis 804, 880
  Isobranchia 803, 806, 880
  Pseudocycnus 694, 695

Thysanote 755, 759, 878
appendiculatus, Pseudocycnus 694, 695
aquilonius, Metataeniacanthus 871
ardeolae, Holobomolochus 49
arii, Caligus 237, 243, 279, 280
ariomus, Euryphorus 490
armatus, Hermilius 411
Pseudocycnus 693, 694, 695, 697, 699, 700
Artacolax 48
aspera, Eudactylina 640
asymmetricus, Caligus 235, 245, 246
atlantica, Elytrophora 493
atlanticus, Euryphorus 490
attenuatus, Holobomolochus 49
australis, Nesippus 179
auxisi, Caligus 236, 247, 248, 872

Bariaka 630, 635, 876, 877
alopiae 635, 636
Bassettithia 693, 694, 877
belloti, Peroderma 747
belones, Bomolochus 33, 34
Lernanthropus 606
benedeni, Sciaenophilus 391, 392
bengoensis, Caligus 274
benneti, Caligus 873
Sciaenophilus 391, 873
bicaudata, Peniculisa 734, 737
bicaudatus, Pseudocharopinus 771
bicolor, Pandarus 150
bicycletus, Caligus 237, 250, 251, 252
bifidus, Lepeophtheirus 432
bilobata, Clavellopsis 809, 810
bilobatus, Trebius 220
biseriodentatus, Caligus 873
bombayensis, Caligus 334
Pseudopandarus 165, 168
Bomolochidae 30, 867, 868
Bomolochinae 31
Bomolochoides 32, 33
Bomolochus 30, 31, 32, 33, 868, 869
anonymous 33
belones 33, 34
concinnus 33
constrictus 33
cuneatus 33
decapteri 33
eminens 33
ensiculus 33
exilipes 33
hemirhamphi 33, 34, 36
hyporhamphi 33
megaceros 33, 34, 38
monoceros 33, 34, 41
multiceros 34, 43, 45, 46
mycterobius 33
nitidus 33
parvulus 33
psettobius 33
scutigerulus 33
selaroides 33, 34, 46
sinensis 33
soleae 32, 33
tumidus 33
unicirrus 33
Boylea 868
Brachiella 749, 781, 782, 787, 879
albida 781, 782
gulosa 781, 784
indica 781, 782, 784, 789, 792, 879
lutiani 781, 782, 789, 792
magna 879
malabarica 879
merlucii 781
otolithi 781, 782, 792, 793
thynni 781, 782, 787, 879
trichiuri 781, 782, 783, 787, 804
brachyptera, Elytrophora 493, 494, 500, 501
brachyurus, Lepeophtheirus 433
branchialis, Anuretes 454, 459
Heniochophilus 459, 461
branchiata, Peroderma 747
Branchiochondrites 132
brevicauda, Pupulina 423, 427
brevicaudus, Caligus 239, 255
brevicephalus, Lernanthropus 527, 533
brevicollis, Ceratochondria 136
brevipedis, Pseudocaligus 368
brevisoris, Caligus 277
breviventris, Lepeophtheirus 432
brogniarti, Lernaeopoda 750

cadenati, Lernanthropus 528, 535

Caetrodes 701, 702, 704
pholas 702
Caligidae 230, 867, 871
Caliginae 232, 868
caliginus, Synestius 401, 402
Caligodes 233, 407
alatus 407
carangis 407
laciniatus 407
lamarckii 407
megacephalus 407
caligodes, Tuxophorus 473
Caligotrogus 141
kapuri 141
Caligus 231, 232, 233, 234. 872
acutus 353
affinis 353
afurcatus 367
alaihi 873
alalongae 264
aliuncus 274
alveolaris 290
amblygenitalis 235, 239, 872
amplyfurcus 314
annularis 236, 241
arii 237, 243, 297, 280
asymmetricus 235, 245, 246, 872
auxisi 236, 247, 248, 872, 873
bengoensis 274
benneti 873
bicycletus 237, 250, 251, 252
biseriodentatus 872, 873
bombayensis 334
bonito 872
brevicaudus 239, 255
brevisoris 277
canthidermis 337
chiloscyllii 236, 257
chrysophrysi 235, 259
clavatus 237, 262
confusus 237, 264
constrictus 238, 267
cordyla 239, 269
cornutus 239, 272
coryphaenae 238, 274, 872
cossacki 276
cunicephalus 353, 365
curtus 234, 345
cybii 238, 277, 872
dakari 279
dasyaticus 235, 280
diaphanus 282, 872
distortus 237, 285
djedabae 250
dussumieri 384
eleutheronemi 285
elongatus 274
enormis 367
epinepheli 236, 287
euthynnus 238, 290
furcisetifer 235, 292
glandifer 241
hamruri 237, 294
hilsae 364, 873
holocentri 236, 296, 873
indicus 236, 298
infestans 236, 301, 872
kanagurta 238, 303
katuwo 340
klawei 241
krishnai 252
kuroshio 252, 254
lagocephali 236, 305
laticaudus 238, 308
lepeophtheropsis 292
lobatus 340
lobodes 239, 309
longicaudus 238, 312
longicervicis 365
longipedis 235, 314
longipes 314
lucidus 314
maculatus 301
malabaricus 236, 317
minutus 257
monacanthi 340
multispinosus 238, 319
nengai 237, 321, 873
parapetalopsis 237, 323
pelagicus 237, 325
pelamydis 303, 305
phipsoni 236, 328
planktonis 234, 330
platurus 237, 332
platytarsis 238, 334
polycanthi 235, 337

priacanthi 235, 338
productus 236, 340, 872
pterois 350
quadratus 236, 342
raniceps 345
reniformis 873
robustus 238, 345
rotundigenitalis 238, 348
rufus 367
rugosus 314
russelli 235, 350
savala 237, 353, 872
scabiei 314
sciaenae 355
sphyraeni 262
tenago 252
tenax 239, 356
tesserifer 274
thynni 245
tylosuri 235, 358
undulatus 237, 360
unguidentatus 237, 362
uruguayensis 235, 365
capitulus, Pumiliopes 88
carangis, Caligodes 407
Lernanthropus 558
Midias 267
Parechetus 397, 398, 400
carchariae, Alebion 502, 512
Taeniacanthus 98
carchariae-glauci, Kroyeria 680
carchariarum, Nemesis 662
carcharini, Pandarus 151, 153
Cardiodectes 716, 727, 877
anchorellae 727
krishnai 728
medusaeus 727
canthidermis, Caligus 337
Caritus 874
serratus 874
caudata, Hatschekia 702, 711
caudatus, Pseudopetalus 384, 386
Trebius 220, 224
Ceratochondria 125, 136
brevicollis 136
hoi 136
cernae, Hatschekia 713
cervicornis, Pennella 745
Tuxophoropsis 477
Tuxophorus 472
chaetodontis, Pseudanuretes 464, 465, 466
Charopinopsis 758, 778
albida 778, 779, 782
quaternia 778, 779
Charopinus 757, 771
chefoonensis, Pseudocongericola 713, 714
chiloscyllii, Caligus 236, 257
chirocentrosus, Lernanthropus 527, 538
Chondracanthidae 123, 867, 871
Chondracanthinae 124
Chondracanthus 125
elongatus 125
chordata, Clavellisa 794, 800, 802, 803, 879
chorinemi, Lernanthropodes 607, 610
chrysophrys, Caligus 235, 259
Lernanthropus 526, 540
clavatus, Caligus 237, 262
Clavella 807, 879
ovata 879
uncinata 807, 809, 879
Clavellinae 750, 757
Clavellisa 758, 793, 879
chordata 794, 800, 802, 803, 879
dussumieria 794, 796
emarginata 794, 879
hilsae 794, 798, 879
ilishae 794, 798, 879
obchordata 794, 796
pellonae 794, 800, 802, 803, 879
phasa 794, 802, 803
spinosa 794
Clavellopsis 803, 809
appendiculata 804, 806
bilobata 809
johni 804
laciniata 809
trichiuri 784, 804
Clavisodalis 870
coleoptratus, Echthrogaleus 187, 188
communis, Perisoppus 171
concavus, Pseudocharopinus 771
concinnus, Bomolochus 33

confusus, Caligus 237, 264
Holobomolochus 49
congeri, Pseudotaeniacanthus 119
Congericola 630
constrictus, Bomolochus 33
Caligus 238, 267
Parechetus 397, 400
cordyla, Caligus 239, 269
corniger, Lernanthropus 527, 541
cornutus, Caligus 239, 272
Lernanthropus 604
Nothobomolochus 53
Phyllothereus 197
coryphaenae, Caligus 238, 274
Elytrophora 493
Euryphorus 490
cossacki, Caligus 276
costatus, Gloiopotes 485
Nesippus 175
cranchi, Pandarus 151, 159, 161
crassus, Alebion 502, 506
Lepeophtheirus 433, 443
crenatus, Perisoppus 171
cresseyi, Lepeophtheirus 433, 449
cruciatus, Lernanthropus 526, 543
crypturus, Nesippus 174, 175
cuneatus, Bomolochus 33
cunicephalus, Caligus 353, 365
curticaudus, Paralebion 515
curtus, Caligus 234, 345
curvatus, Eudactylinopsis 631
cybii, Caligus 238, 277
Tuxophoropsis 477
Tuxophorus 472
Cybicola 693, 694, 877
Cyclopoida 28, 29
Cycnus 694
cylindricum, Peroderma 746, 747
cynoglossi, Parataeniacanthus 110
cypseluri, Nothobomolochus 53, 54, 79

dactylopterusi, Orbitacolax 80
dakari, Caligus 279
dasyaticus, Caligus 235, 280
Pseudocharopinus 771, 776
decapteri, Bomolochus 33
Lernanthropus 526, 545
decemfimbriata, Thysanote 768
Demoleus 148
Dendrapta 771
dentatus, Perisoppus 171, 173
Pseudocharopinus 771
Taenicanthus 98, 99
denticulatus, Echthrogaleus 187, 188, 192, 195
Nothobomolochus 53, 57
Dentigryps 431, 432, 449
descrepans, Dinemoura 208, 212
diaphanus, Caligus 282
Dichelesthiidae 700, 867, 875, 876, 877
Dichelesthium 700, 877
Dicrobomolochus 31
difficilis, Alebion 512
digitatus, Nothobomolochus 53, 60
Dinematura 207
Dinemoleus 871
Dinemoura 149, 207, 208, 871
descrepans 208, 212
ferox 208
latifolia 208
producta 208
Dissonidae 140, 867
Dissonus 140, 141
furcatus 141, 143
kapuri 141
ruvetti 141, 146
spinifer 141, 144
distortus, Caligus 237, 285
djedabae, Caligus 250
dussumieri, Caligus 384
Lernanthropus 527, 547
Pseudopetalus 384
dussumieria, Clavellisa 794, 796

echinata, Kroyeria 671, 686
echinatus, Alebion 506
Echiniurus 870
Echinoscius 870
echinus, Indocaligus 439
Echthrogaleus 149, 186
coleoptratus 187, 188
denticulatus 188, 192
pectinatus 188, 196
pellucidus 187, 195

torpidinis 188
Eirgos 467
elegans, Alebion 502, 514
Pennella 741, 742
elegata, Shiinoa 871
eleutheronemi, Caligus 285
Thysanote 759, 768
elliptica, Hatschekia 702, 709
elongata, Kroyeria 681
Pupulina 423
elongatus, Caligus 274
Chondracanthus 125
Paeon 813
Paralebion 515, 516
Elytrophora 479, 492, 494
atlantica 493
brachyptera 493
coryphaenae 493
hemiptera 493, 494
indica 493, 498
emarginata, Clavellisa 794, 879
eminens, Bomolochus 33
enneacentri, Sagum 620, 623
enormis, Caligus 367
ensiculus, Bomolochus 33
Epachthys 520
epigri, Metataeniacanthus 870
epinepheli, Caligus 236, 287
Sagum 620
epulus, Nothobomolochus 53
errans, Euryphorus 490
Eucanthus 98
Eudactylina 630, 639, 640, 876, 877
acuta 640
alata 640, 651
aspera 640
lancifera 640, 654
olivieri 640, 647
pollex 640, 645
puriensis 657
pusilla 640, 642
Eudactylinella 630
Eudactylinidae 629, 867, 876, 877
Eudactylinodes 630
Eudactylinopsis 630, 876, 877
curvatus 631
Euryphoridae 470, 867
Euryphorinae 478
Euryphorus 479, 489
ariomus 490
atlanticus 490
coryphaenae 490
errans 490
murrayi 490
nordmanni 490
nympha 490
pacificus 490
euthynnus, Caligus 238, 290
exilipes, Bomolochus 33
exilis, Trebius 221

fallolunulus, Lepeophtheirus 875
ferox, Paeon 813
fistula, Peniculus 729
fistulariae, Pseudocaligus 368, 369
flagellatum, Sagum 619
flores, Pupulina 423
foliata, Hatschekia 702, 706
forficatus, Lernanthropus 526, 551
formicoides, Parapetalus 389
fortipedis, Pseudanuretes 464, 465, 875
fugu, Pseudocaligus 368
furcata, Peniculisa 734
Thysanote 759, 766
furcisetifer, Caligus 235, 292
fuscus, Alebion 512

galatheae, Praecidochondria 871
Gangliopus 149, 202
japonicus 203
pyriformis 203
tetrapturi 203
gerresi, Nothobomolochus 53, 61
gibber, Nothobomolochus 53, 63
gibbosus, Lernanthropus 526, 553
gibbsi, Metataeniacanthus 870
giganteus, Lernanthropus 528, 555
glandifer, Caligus 241
globosus, Aethon 614
Gloiopotes 479
americanus 480
costatus 485
huttoni 480, 481, 485
hygomianus 480, 481, 486
longicaudatus 481

ornatus 480
watsoni 480, 481
zeugopteri 485
gobii, Anchistrotos 122
gonistii, Lepeophtheirus 433, 446
gracilis, Alebion 502, 510
Kroyeria 671, 677
Nesippus 175
Pseudopandarus 165
gulosa, Brachiella 781, 784
gunteri, Parapetalus 375, 380
gymnobranchiata, Thysanote 878

hamruri, Caligus 237, 294
hapalogenyos, Orbitacolax 80
Hatschekia 701, 702, 876, 877
caudata 702, 711
cernae 713
elliptica 702, 709
foliata 702, 706
hippoglosi 701
ovalis 702, 704
pholas 702
sphyraeni 702, 708
Hatschekiidae 867, 876, 877
helleri, Hermilius 411, 418
Helleria 694, 697
hemigalei, Tripaphylus 814, 880
hemiptera, Elytrophora 493, 494
hemirhamphi, Bomolochus 33, 34, 36
Lernaeenicus 717
Heniochophilus 453, 458, 459, 875
branchialis 459
indicus 459, 462, 875
japonicus 459, 461
Hermilius 410, 411
armatus 411
helleri 411, 418
longicornis 412, 416
pyriventris 411, 412
tachysuri 411, 420
youngi 412
Heterochondria 132
crassicornis 132
longa 132, 134
longicephala 132
pillaii 132, 133
heterodactyla, Thysanote 759, 766
heteropodus, Leranthropus 550
hilsae, Caligus 364
Clavellisa 794, 798, 879
hippoglosi, Hatschekia 701
hirsutus, Parapetalus 375, 376
hoi, Ceratochondria 136
Holobomolochus 31, 48
acutus 49
albidus 49
ardeolae 49
attenuatus 49
confusus 49
nemipteri 49, 869
nothrus 49
occultus 49
palleucus 49
prolixus 49
spinulus 49
venustus 49
holocentri, Caligus 236, 296
Holocolax 869
longisetus 869
russelli 869
Homoiotes 431, 432
palleata 432
huttoni, Gloiopotes 480, 481, 485
hygomianus, Gloiopotes 480, 481, 486
hyporhamphi, Bomolochus 33

ilishae, Clavellisa 794, 798, 879
indica, Brachiella 782, 784, 789
Elytrophora 493, 494, 498
indicus, Caligus 236, 298
Heniochophilus 459, 462
Lernanthropus 528, 558
Taeniacanthus 99, 100
Indocaligus 439
echinus 439
infestans, Caligus 236, 301
inopinus, Sciaenophilus 392
Irodes 97, 98, 870
anguillaris 870
Isobranchia 803, 879
appendiculata 804, 806, 880

japonicus, Gangliopus 203
Heniochophilus 459, 461
javanicus, Trebius 221, 224

johni, Clavellopsis 804
jonesi, Pumiliopes 88, 872

Kabataella 872
kabatai, Pseudocharopinus 771, 773
kanagurta, Caligus 238, 303, 305
Lernanthropus 541
Nothobomolochus 53, 66, 69
kapuri, Caligotrogus 141
Dissonus 141
katuwo, Caligus 340
kirtii, Trebius 220, 223
klawei, Caligus 241
koenigi, Lernanthropus 528, 560
krishnai, Cardiodectes 727, 728
Kroyeria 630, 670, 671, 876, 877
carchariae-glauci 680
dispar 671
echinata 671, 686
elongata 681
gemursa 671, 674
gracilis 671, 677
lineata 670
longicauda 671, 683
minuta 671, 690
spatulata 671, 681
sphyrnae 671, 688
Kroyeriidae 867, 876, 877
Kroyerina 630

laciniata, Clavellopsis 809
laciniatus, Caligodees 407
lagocephali, Caligus 236, 305
Lepeophtheirus 433, 441
Taeniacanthus 98, 102
lamarcki, Caligodes 407
laminatus, Pseudocaligus 368, 371
Laminifera 197
lamna, Nemesis 657, 658, 662
Lamproglena 630
lancifera, Eudactylina 640, 654
lappaceus, Lernanthropus 527, 562
lateolabracis, Nothobomolochus 53
latesi, Lernanthropus 566
laticaudus, Caligus 238, 308
latifolia, Dinemoura 208
latifurcatus, Trebius 220
latigenitalis, Lepeophtheirus 432, 447
latis, Lernanthropus 527, 566
lativentris, Lernanthropus 527, 568
leiognathi, Lernanthropus 528, 572
Lepeophtheirus 410, 431, 432, 872, 874, 875
aesopus 433, 435
anguilli 874
bifidus 432
brachyurus 433
breviventris 432
crassus 433, 443
cresseyi 433, 449
elongatus, 516
fallolunulus 875
gonistii 433, 446
lagocephali 433, 441
latigenitalis 432, 447
longicauda 449
longipalpus 433, 439
palliata 432
parvipes 432
pectoralis 432
plotosi 874
rotundigenitalis 875
rotundiventris 433, 436
spinifer 433, 436
Lepeophtherinae 410, 868
lepeophtheropsis, Caligus 292
leptoscari, Orbitacolax 80
Lernaea 714, 715
Lernaeenicus 716, 717, 877
alatus 717, 723
anchoviellae 717, 726
hemirhamphi 717
longiventris 717, 724
nemipteri 717, 721
polynemi 717, 725
radiatus 717
ramosus 717, 719

sayori 717, 723
seeri 717, 725
stromatei 717, 722
Lernaeoceridae 714, 877
Lernaeolophus 716, 737, 877
sultanus 738
Lernaeopoda 750, 751, 877, 878
brogniarti 750

scoliodontis 751, 755, 878
stromatei 751, 753, 878
uepnei 751, 878
Lernaeopodidae 748, 750, 867, 877
Lernaeopodoida 748
Lernanthropidae 867, 876
Lernanthropodes 521, 607, 876
chorinemi 607, 610
cuculus 607, 610
trachinoti 607, 608
Lernanthropus 521, 524, 526, 876
abitocephalus 527, 528
alatus 528, 531
belones 606
brevicephalus 527, 533
cadenati 528, 535
carangis 558
chirocentrosus 527, 538
chrysophrys 526, 540
corniger 527, 541
cornutus 604, 606
cruciatus 526, 543
decapteri 526, 545
dussumieri 527, 547
engraulis 528, 550
forficatus 526, 551
gibbosus 526, 553, 876, 877
giganteus 528, 555
heteropodus 550
indicus 528, 558
kanagurta 541
koenigi 528, 560
lappaceus 527, 562
latesi 566
latis 527, 566
lativentris 527, 568
leiognathi 528, 572
microlamini 603
musca 525
nemipteri 527, 574
nudus 577
oblongus 527, 577
opisthopteri 527, 581
otolithi 527, 583
pami 527, 583
pomadasysis 528
pristipomoides 527, 585
robustus 527, 586
rubiginosus 527, 588
sciaeni 528, 589
secutoris 528, 591
shishidoi 526, 696
sillaginis 527, 594
sphyraenae 526, 598
temminckii 876
triangularis 528, 599
trifoliatus 527, 601
tylosuri 527, 604
villiersi 594, 595
lineata, Kroyeria 670
lobodes, Caligus 239, 309
Midias 309, 312
longicauda, Kroyeria 671, 683
Lepeophtheirus 449
Pennella 741, 743
Pseudotaeniacanthus 119
longicaudatus, Gloiopotes 481
Tribius 220
longicaudus, Caligus 238, 312
Taeniacanthus 99, 104
longicephala, Heterochondria 132
longicervicis, Caligus 365
Parataeniacanthus 111, 113
longicornis, Hermilius 412, 416
longimana, Thysanote 759, 762
longipalpus, Lepeophtheirus 433, 439
longipedis, Caligus 235, 314
longipennatus, Parapetalus 375, 378
longipes, Caligus 314
longisetus, Holocolax 869
longus, Pseudopandarus 165, 168
Lophoura 812
lucidus, Caligus 314
lutiani, Brachiella 782, 789, 879
Neobrachiella 879

maculatus, Alebion 502
Caligus 301
magna, Brachiella 879
malabarica, Brachiella 879
malabaricus, Caligus 236, 317
malleus, Pseudocharopinus 771
managatuwo, Nothobomolochus 52, 74
manuelensis, Perisoppus 171
Mappates 453, 466, 467
alter 467, 470

plataxus 467
markewischi, Pseudocharopinus 771, 776
Medesicaste 125, 138
penetrans 138
mediterranea, Nemesis 662
medusaeus, Cardiodectes 727
megacephalus, Alebion 502
Caligodes 407
megaceros, Bomolochus 34, 38
menehune, Anuretes 454
merluci, Brachiella 781
Metacaligus 367
Metahatschekia 701
Metataeniacanthus 97, 115, 870
aquilonius 871
epigri 870
gibbsi 870
nudus 870
synodi 116, 870
vulgaris 870
microlamini, Lernanthropus 603
Midias 267, 272, 274, 309
carangis 267
lobodes 272, 274, 309
miles, Parataeniacanthus 110, 111
minutus, Caligus 257
minor, Pupulina 423, 424
moa, Anchistrotos 122
monacanthi, Caligus 340
monoceros, Bomolochus 34, 41
Mugilicola 715
multiceros, Bomolochus 34, 43
multifimbriata, Thysanote 759, 764
multispinosus, Caligus 238, 319
Nothobomolochus 53, 69
muraenesocis, Pseudotaeniacanthus 871
murrayi, Euryphorus 490
musca, Lernanthropus 525
musteli, Tripaphylus 814, 880
mycterobius, Parabomolochus 33

nana, Nesippus 174
narcinae, Pseudocharopinus 771, 772
narcini, Taeniacanthus 99, 107
Nemesis 630, 657, 658, 876, 877
aggregatus 658
carchariarum 662
lamna 658, 662
mediterranea 662
pallida 664
robusta 658, 664
versicolor 658, 668
nemipteri, Holobomolochus 49, 869
Lernaeenicus 717, 721
Lernanthropus 527, 574
nengai, Caligus 237, 321, 873
Neobomolochus 869
Neobrachiella 878, 879
Nesippus 149, 174
alatus 179
australis 179
costatus 175
crypturus 174, 175
gracilis 175
nana 174
occultus 175
orientalis 174, 175, 179
ornatus 179
tigris 174, 175, 182
vespa 175, 184
nibeae, Sciaenophilus 391
niger, Pandarus 151
nitidus, Bomolochus 33
nordmanni, Euryphorus 489, 490
Norion 520, 521, 526, 535, 572, 613, 876
Nothobomolochus 31, 52, 53
cornutus 53
cypseluri 53, 54, 79
denticulatus 53, 57
digitatus 53, 60
epulus 53
gerresi 53, 61
kanagurta 53, 66
lateolabracis 53
managatuwo 52
multispinosus 53, 69
quadriceros 53 72
saetiger 53
scomberesocis 52
triceros 53, 74
trichiuri 54, 77
nothrus, Holobomolochus 49
nudibranchiata, Thysanote 878

nudus, Lernanthropus 577
Metataeniacanthus 870
Orbitacolax 80
Pseudorbitacolax 84
nympha Euryphorus, 490

obchordata, Clavellisa 794
oblongatus, Perisoppus 171
oblongus, Lernanthropus 527, 577
occidentalis, Parapetalus 375, 380
occlusa, Shiinoa 871
occultus, Holobomalochus 40
octofimbriota, Thyoanote 68
olivieri, Eudactylina 640, 647
oniscoides, Orbitacolax 80
Opimia 812
opisthopteri, Lernanthropus 527, 581
Pumiliopes 88
Orbitacolax 31, 80
aculeatus 80, 81
analogus 80
dactylopterusi 80
hapalogenyos 80
leptoscari 80
nudus 80, 81, 869
oniscoides 80
uniunguis 13
orientalis, Parapetalus 375, 382
ornatus, Gloiopotes 480
Nesippus 179
otolithi, Brachiella 781, 782, 792
Lernanthropus 527, 583
ovata, Clavella 879

pacificus, Euryphros 490
Paeon 812
elongatus 813
ferox 813
lobatus 813
vaissieri 813
versicolor 813
Paeonodes 812
Pagina 148, 149, 217
tunica 217
palleata, Homoiotes 432
palleucus, Holobomolochus 49
palliata, Lepeophtheirus 432
pallida, Nemesis 664
pami, Lernanthropus 527, 583
Pandaridae 147, 867, 871
Pandarus 149, 150
bicolor 150
carcharini 151, 153
cranchii 151, 159
niger 151
satyrus 151, 157
smithi 151, 162
Pannosus 148
Parabomolochus 32, 33
Paracycnus 693, 694
Paralebion 515
eurticaudus 515
elongatus 515, 516
pearsi 515
Paralernanthropus 520, 521, 876
Paranesippus 148
Parapandarus 197
parapetalopsis, Caligus 237, 323
Parapetalus 233, 374, 874
gunteri 375, 380
hirsutus 375, 376
longipennatus 375, 378
occidentalis 375, 380
orientalis 375, 382, 874
Parataeniacanthus 97, 109, 111, 870
cynoglossi 110
longicervis 111, 113
miles 111
pseudorhombi 110
russelli 870
Parechetus 233, 306, 871, 872, 874
carangis 397, 398. 874
constrictus 397, 400, 874
parvipes, Lepeophtheirus 432
parvulus, Anuretes 454
parvus, Pseudocaligus 368, 372
pearsi, Paralebion 515
pectinatus, Echthrogaleus 188, 196
pectoralis, Lepeophtheirus 432
pelagicus, Caligus 237, 325
pelamydis, Caligus 303
pellonae, Clavellisa 794, 800, 879
pellucidus, Echthrogaleus 187, 195
penetrans, Medesicaste 138
Peniculissa 716, 733, 734, 877
bicaudata 734

furcata 734
shiinoi 734
wilsoni 734, 735
Peniculus 716, 729, 877
fistula 729
sciaeni 731
scomberi 733
stromatei 732
theraponi 731
trichiuri 729
Pennella 716, 740, 741, 877
biloba 741, 745
cervicornis 745
diodontis 741, 745
elegans 741, 742
instructa 741, 744
longicauda 741, 743
platycephala 741, 742
robusta 741
sagittata 740
selaris 741, 746
zeylanica 744
Pennellidae 867, 877
Periplexis 812
Perisoppus 149, 170, 171
communis 171
crenatus 171
dentatus 171, 173
manuelensis 171
oblongatus 171
serratus171
travancorensis 171
Peroderma 716, 746, 877
belloti 747
branchiata 747
cylindricum 746, 747
petersi 747
perplexus, Anuretes 454
petersi, Peroderma 747
Sagum 619
Phagus 97
pharaonis, Sciaenophilus 391, 392
phasa, Clavellisa 794, 802
phipsoni, Caligus 236, 328
pholas, Hatschekia 702
Phyllophora 197
Phyllothereus 149, 197
cornutus 197
pillaii, Heterochondria 132, 133, 134
Proclavellodes 807
planktonis, Caligus 234, 330
plataxus, Mappates 407
platurus, Caligus 237, 332
platycephala, Pennella 741, 742
platyrostris, Abasia 404
platytarsis, Caligus 238, 334
plautus, Pumiliopsis 90, 94
plotosus, Lepeophtheirus
pollex, Eudactylina 640, 645
polyfimbriata, Thysanote 878
polynemi, Lernaeenicus 717, 725
pomacanthi, Pseudanuretes 465
pomacanthodi, Pseudanuretes 875
pomadasysis, Lernanthropus 528
posteli, Sagum 619
Praecidochondria 871
galatheae 871
setoensis 871
priacanthi, Aethon 614, 616, 629
Caligus 235, 338
pristipomoides, Lernanthropus 527, 585
Proclavellodes 758, 806
pillaii 807
producta, Dinemoura 208
productus, Caligus 236, 340
Prohatschekia 701
prolixus, Holobomolochus 49
Protochondracanthus 125, 127
alatus 128
psettodes 128
trilobatus 128, 130
psettobius, Bomolochus 33
psettodes, Protochondracanthus 128
Pseudanuretes 453, 464, 465, 875
chaetodontis 464, 465
fortipedis 464, 465, 875
pomacanthi 464, 465
pomacanthodi 875
schmidti 464, 465
Pseudartacolax 31, 83
Pseudechetus 871
Pseudocaligus 232, 367, 368, 873
apodus 368
brevipedis 368
fistulariae 368, 369

fugu 368
indicus 873
laminatus 368, 371
parvus 368, 372
similis 369
smithi 873, 874
subparvus 873, 874
tenuicauda 369
Pseudocharopinus 758, 770, 771, 878
bicaudatus 771
concavus 771
dasyaticus 771, 776, 878
dentatus 771
kabatai 773, 878
malleus 771
markewitschi 771
narcinae 771, 772
squali 771
Pseudochondracanthus 133, 136
Pseudoclavella 701
Pseudocongericola 700, 701, 713, 876, 877
chefoonensis 713, 714
Pseudocycnidae 692, 867, 876, 877
Pseudocycnoides 693, 877
Pseudocycnopsis 693
Pseudocycnus 693, 694, 695, 876, 877
appendiculatus 694, 695
armatus 695, 697
Pseudoeucanthus 31
Pseudohatschekia 700
Pseudolepeophtheirus 452
Pseudolernanthropus 520, 618
Pseudopandarus 149, 164
bombayensis 165, 168
gracilis 165
longus 165, 168
scylli 165
shiinoi 165, 168
Pseudopetalus 233, 384
caudatus 384, 386, 873
dussumieri 384
formicoides 384, 389
Pseudorbitacolax 31, 83, 869
nudus 84
varunae 84
pseudorhombi, Parataeniacanthus 110
Pseudorostris, Abasia 404
Pseudotaeniacanthus 97, 118, 871
congeri 119
longicauda 119
muraenesocis 871
puhi 119
pterois, Caligus 350
puhi, Pseudotaeniacanthus 119
Pumiliopes 32, 87, 870
capitulus 88, 870
jonesi 88, 870
opisthopteri 88
squamosus 88
Pumiliopsis 32, 89
emarginatus 90, 870
plautus 90, 94
sardinellae 90, 870
spathepedis 94
Pupulina 410, 422
aliuncus 423
brevicauda 423, 427
elongatus 423
flores 423
minor 423, 424
thompsoni 423
puriensis, Eudactylina 657
pusilla, Eudactylina 640, 642
pyriformis, Gangliopus 203
pyriventris, Hermilius 411, 412

quadratus, Aethon 612
Caligus 236, 342
quadriceros, Nothobomolochus 53, 72
quadrilaterus, Anuretes 454
quaternia, Charopinopsis 778, 779

radiatus, Lernaeenicus 717
ramosus, Lernaeenicus 717, 719
raniceps, Caligus 345
rastrelligeri, Thysanote 759, 767
renalis, Anuretes 454
reniformis, Caligus, 873
robusta, Nemesis 658, 664
Pennella 741
robustus, Caligus 238, 345
Lernanthropus 527, 586
rostrata, Shiinoa 871
rotundigenitalis, Anuretes, 875
Caligus 238, 348

Lepeophtheirus, 875
rotundus, Anuretes, 875
rubiginosus, Lernanthropus 527, 588
rufus, Caligus 367
rugosus, Caligus 314
russelli, Caligus 235, 350
Holocolax 869
ruvetti, Dissonus 141

saetiger, Nothobomolochus 53
sagittata, Pennella 740
Sagum 521, 620, 876
angulatum 619, 620
enneacentri 620, 623
epinepheli 620
flagellatum 619
petersi 619
posteli 619
texanum 619
tuberculatum 620, 626
satyrus, Pandarus 151, 157
sauridi, Anchistrotos 122
savala, Caligus 237, 353
sayori, Lernaeenicus 717, 723
scabiei, Caligus 314
Schistobranchia 771
schmidti, Pseudanuretes 465
sciaenae, Caligus 355
sciaeni, Lernanthropus 528, 589
Peniculus 731
Sciaenophilus 233, 390, 391
benedeni 391
benneti 391
inopinus 392
nibeae 391
pharaonis 391, 392
tenuis 391, 395
Scolecicara 97
scoliodontis, Lernaeopoda 751, 755
scomberesocis, Nothobomolochus 53
scomberi, Peniculus 733
scutigerulus, Bomolochus 33
scylli, Pseudopandarus 165
secutoris, Lernanthropus 528, 591
seeri, Lernaeenicus 717, 725
selaris, Pennella 741, 746
selaroides, Bomolochus 33, 34, 46
sepheni, Trebius 220, 227
serratus, Anuretes 454
Caritus 874
Perisoppus 171
setoensis, Praecidochondria 871
Shiinoa 871
elegata 871
occlusa 871
rostrata 871
shiinoi, Anuretes 875
Peniculisa 734
Pseudopandarus 165, 168
Shiinoidae 867, 871
shishidoi, Lernanthropus 526, 596
sillaginis, Lernanthropus 527, 594
similis, Pseudocaligus 368, 369
sinensis, Bomolochus 33
Sinocaligus 389
similis, Heterochondria 132
smithi, Pandarus 151, 162
Pseudocaligus 873
solandri, Tuxophorus 477
soleae, Bomolochus 32, 33
spathepedis, Pumiliopsis 94
spatulata, Kroyeria 671, 681
sphyraenae, Lernanthropus 526, 598
sphyraeni, Caligus 262
Hatschekia 702, 708
Sphyriidae 748, 812, 867
Sphyrion 812
sphyrnae, Kroyeria 671, 688
spinifer, Dissonus 141, 144
Lepeophtheirus 433, 436
spinosa, Clavellisa 794
spinosus, Alebion 502
spinulus, Holobomolochus 49
squali, Pseudocharopinus 771
squamosus, Pumiliopes 88
Strabax 124
stromatei, Lernaeenicus 717, 722
Lernaeopoda 751, 753
subparvus, Pseudocaligus 873
sultanus, Lernaeolophus 737, 738
Synestius 232, 401
caliginus 401
synodi, Metataeniacanthus 116

tachysuri, Hermilius 411, 420
Taeniacanthidae 29, 96, 97, 867, 870

Taeniacanthodes 97
Taeniacanthus 98, 870
carchariae 98
dentatus 98, 99
indicus 99, 100
lagocephali 98, 102
longicaudus 99, 104
narcini 99, 107
tetradonis 109
yamagutii 109
Tegobomolochus 868
temmenckii, Lernanthropus 876
tenago, Caligus 252
tenax, Caligus 239, 356
tenuicauda, Pseudocaligus 368, 369
tenuifurcatus, Trebius 220
tenuis, Sciaenophilus 391, 394
tesserifer, Caligus 274
tetradonis, Taeniacanthus 109
tetrapturi, Gangliopus 203
texanum, Sagum 619
theraponi, Peniculus 731
Therodamas 715
thynni, Caligus 245
Brachiella 782, 787
Thysanote 757, 758, 759, 878
appendiculata 759, 878
decemfimbriata 768
eleutheronemi 768
furcata 759, 766
gymnobranchiata 878
heterodactyla 759, 766
longimana 759, 762
multifimbriata 759, 764
nudibranchiata 878
octofimbriata 768
polyfimbriata 878
rastrelligeri 759, 767
Thysanotella 758
tigris, Nesippus 175, 182
torpidinis, Echthrogaleus 188
travancorensis, Perisoppus 171
Trebiidae 140, 220, 867
Trebius 220
akajei 220
bilobatus 220
caudatus 220
exilis 221
javanicus 221
kirtii 220,223
latifurcatus 220
longicaudatus 220
sepheni 220, 227
tenuifurcatus 220
triangularis, Lernanthropus 528, 599
triceros, Nothobomolochus 53, 74
Tricolax 869
trichiuri, Brachiella 781, 782, 784 786, 787
Clavellopsis 784, 786, 787, 804
Nothobomolochus 53, 54, 77, 79
Peniculus 729
trifoliatus, Lernanthropus 527, 601
Tripaphylus 812, 814, 880
hemigalei 814, 880
musteli 814, 880
tripartitus, Abasia 404
tuberculatum, Sagum 620, 626
tumidus, Bomolochus 33
tunica, Pagina 217
Tuxophorinae 471
Tuxophoropsis 472, 477
cervicornis 477
cybii 477
Tuxophorus 472
caligodes 472, 473
cervicornis 477
cybii 477
solandri 477
tylosuri 358
wilsoni 472, 475
tylosuri, Caligus 235, 358
Lernanthropus 527, 604
Luxophorus 358

undulatus, Caligus 237, 360
unguidentatus, Caligus 237, 362
unicirrus, Bomolochus 33
Unicolax 868, 869
uniunguis, Orbitacolax 80
upenei, Lernaeopoda 751
uruguayensis, Caligus 235, 365

vaissieri, Paeon 813
venustus, Holobomolochus 49
versicolor, Nemesis 658, 668

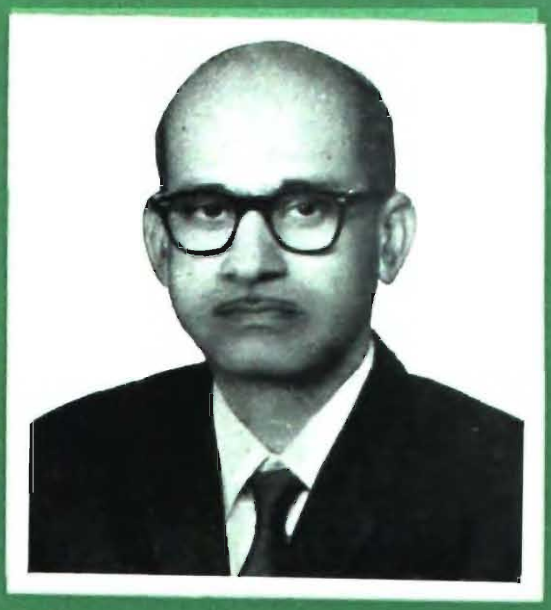
Paeon 813
vespa, Nesippus 175, 184
villiersi, Lernanthropus 594, 595
vulgaris, Metataeniacanthus 870

watsoni, Gloiopotes 480, 481, 486
wilsoni, Peniculisa 734, 735

Tuxophorus 472, 475

yamagutti, Taeniacanthus 109
youngi, Hermilius 412

zeugopteri, Gloiopotes 485
zeylanica, Pennella 744



Dr. N. Krishna Pillai joined the Department of Aquatic Biology and Fisheries, University of Kerala (then Marine Biological Laboratory, University of Travancore) as research scholar in 1943. He retired from service as Professor and Head of the Department, after a long period of continuous service, in 1981.

Dr. Pillai worked exclusively on the taxonomy of crustaceans, mainly Isopoda, Amphipoda, Mysidacea and Copepoda. Though many of his publications on Amphipoda and Mysidacea have received International recognition, his best works are on copepod parasites of marine fishes. During his long academic career Dr. Pillai has published more than 100 papers in Indian and International journals, not counting those in which he is a joint author. More than 50 of his publications are on copepod parasites. Dr. Pillai is one among the outstanding living workers on parasitic copepods.

15 students who worked under the guidance of Prof. Pillai were awarded the Ph.D degree by the Kerala University. Of these 15 students, six worked on copepod parasites.